FUTURE OF KNOWLEDGE

A FORESIGHT REPORT

مؤسسة محمد بن راشد آل مكتوم للمعرفة
MOHAMMED BIN RASHID AL MAKTOUM
KNOWLEDGE FOUNDATION

UNDP

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LEVERAGING TRANSFORMATIVE CAPACITIES TO MEET FUTURE RISKS

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Future of Knowledge: A Foresight Report

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FOREWORD

UNITED NATIONS DEVELOPMENT PROGRAMME

In an era defined by the rapid rate of technological change, countries must be able to identify their shortcomings as well as the many opportunities associated with the Fourth Industrial Revolution. This Future of Knowledge Foresight Report aims to help countries to do just this by examining the 'technological readiness' of economies to transform, both in the context of hard technology and skills. In particular, it focuses on how countries can leverage the power of technology and knowledge to build resilience to future shocks, advance economic growth, and accelerate progress towards the Sustainable Development Goals.

Analysing 40 countries -- using 150 million sources through Artificial Intelligence (A.I.), big data, and machine learning -- the findings of the report show that countries such as Singapore, the United Kingdom, Malaysia, and Luxembourg exhibit high levels of awareness, understanding and adoption of new technologies. In these countries, technology is leveraged as a key driver of sustainable development and as a means to boost their economies' resilience to shocks. For instance, these countries have developed state research, development, and innovation institutions. They have also boosted the digital capacity of critical sectors such as education, financial services, energy, and telecoms. Despite their relative performance, none of these countries has reached their full potential in terms of technological uptake or skills development. Indeed, we are only scratching the surface when it comes to using the power of technology to protect our natural world and take climate action. For instance, is estimated that A.I. and digital technology could help to realize a 10-20 per cent reduction in global carbon dioxide emissions by 2030.

Conversely, the report finds that countries such as Tajikistan, Ethiopia, Egypt, and Kazakhstan exhibited limited awareness of; and engagement with; future technologies. Low levels of awareness, combined with a limited knowledge and skills in relation to new technologies, directly correlates with a lack of capacity and preparedness in the face of future shocks. Yet this baseline, and their youthful demographics provide such countries with the potential to spur rapid technological growth. Expanding access to affordable broadband internet will be pivotal to such efforts in a world where internet usage ranges from approximately 87 per cent of the population in developed countries on average, to less than 20 per cent in developing countries.

As countries aim to build forward better from the devastating socio-economic effects of the COVID-19 pandemic, this report reinforces the need for governments to focus on upskilling their workforces and equipping people with the skills they need to be part of today's digital economies. It highlights, for example, France's Regional Employment and Training Observatory. This A.I. based model identifies the skills gap between companies' future skills needs and current individuals' skills, suggesting training to fill the gap. In doing so, it aims to match labour supply with demand, upskilling citizens in a way that will be relevant in both the short and longer terms. Indeed, South-South and triangular cooperation will be crucial to sharing best practice and innovative ways to boost the digital skills of marginalized populations including women and people with disabilities, for instance.

I wish to express my sincere gratitude to the Mohammed bin Rashid Al Maktoum Knowledge Foundation for its partnership with the United Nations Development Programme (UNDP). With this Future of Knowledge Foresight Report and the Global Knowledge Index, we are helping to close a knowledge gap on how and where countries must invest to build cutting-edge, knowledge-based societies. Doing so will be key to open-up new opportunities in the form of jobs and livelihoods, boosting human development and helping to drive down stubborn poverty and inequalities. Together with our partners, we are presenting a clearer picture of what a greener, more inclusive, and more sustainable future can look like.

Achim Steiner
Administrator, United Nations Development Programme (UNDP)

THE FUTURE KNOWLEDGE LANDSCAPE

METHODOLOGY

GLOBAL ANALYSIS

CONCLUSIONS AND RECOMMENDATIONS


WHAT'S HAPPENING
TODAY
BEAT

01

THE FUTURE KNOWLEDGE LANDSCAPE

01 THE FUTURE KNOWLEDGE LANDSCAPE

1.1 SETTING THE SCENE

Since the 1960s, there has been a tenfold increase in the number of natural disasters worldwide,[1] with the average related economic costs rising from US$50 billion per year in the 1980s to $300 billion in the last decade.[2,3] Despite these being a clear consequence of natural hazard-induced disasters, countries have struggled to take concrete and effective action to reduce their greenhouse gas (GHG) emissions and, more generally, to learn from previous crises despite their deep impacts throughout society. However, disasters – be they natural, manmade or a combination thereof – present possibilities for countries to learn and foster change, to engage in structural and institutional transformation, and to lessen inequality and increase long-term development potential.[4] Yet it is clear that, despite consistent mistakes, governments and organizations have failed to learn from these crises.

AVERAGE ECONOMIC COSTS CAUSED BY NATURAL DISASTERS WORLDWIDE

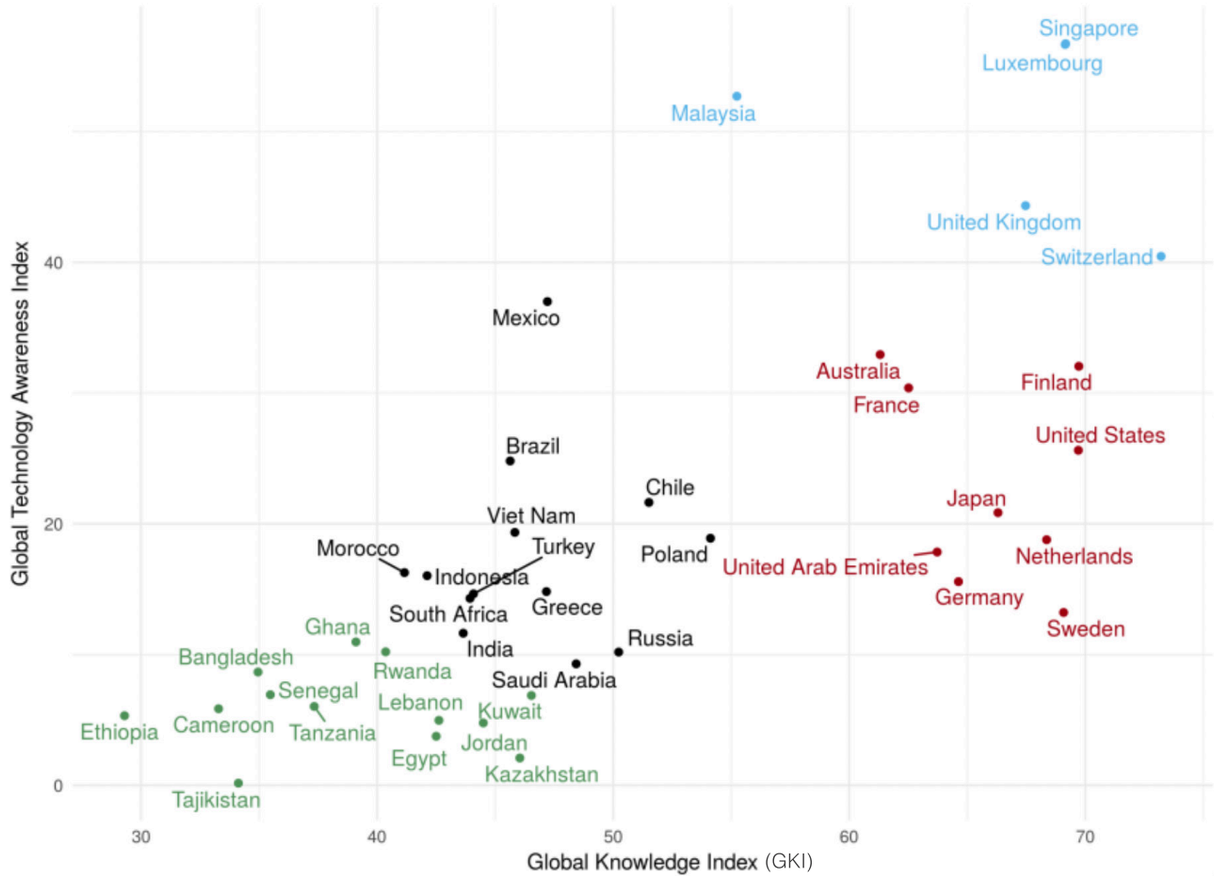
In this context, the COVID-19 pandemic, with its unprecedented global economic, social, political, health and security impacts, has served as a strong reminder of the necessity to learn from previous crises and increase preparedness accordingly. Countries around the world must draw lessons from this pandemic to ensure that the gaps, challenges and issues faced throughout this crisis are reflected in the development of more sustainable and inclusive policies and practices. It is through such proactive and continuous learning that organizations across the globe may: i) ensure their preparedness for disruptions and shocks in an increasingly complex, interconnected and evolving risk landscape; and ii) seize new opportunities for development.

Since 2018, the Future of Knowledge Foresight Reports have examined the preparedness of economies to successfully engage with the future knowledge landscape by analysing emergent signs of both weakness and strength.[5] Embracing technological progress and supporting the development of knowledge-based and modernized skillsets have been identified as crucial to the transformative capacities of countries to become resilient, create sustainable growth and compete in a highly competitive world. Country leaders who have anticipated these needs and implemented national re/upskilling initiatives, recognize such actions as key success factors in ensuring sustainable and inclusive growth, which ultimately contribute to the well-being of citizens.[6] The levels of readiness for technological uptake, in the context of both technology and skills, are vastly different from one country to another. Thus, responsible leadership and concrete investments in the knowledge dimensions of a society are fundamental to addressing future challenges and risks and fostering sustainable and inclusive development.

At one end of the spectrum, countries such as Singapore, the United Kingdom, Malaysia and Luxembourg have performed particularly well. They have developed several initiatives to mobilize sectoral regulators (financial services, energy, telecoms), research, development and innovation (RDI) institutions, the education sector and the economy through multiple, high-level conferences and innovative projects. Such high performers exhibit a high level of awareness, understanding and adoption of new technologies, considering them as key drivers for sustainable development. In turn, this supports their capacities to deal with future technological disruption.[7] Although these countries performed relatively well, none of them have yet reached their full potential in terms of technological uptake and skills development.

On the other side of the spectrum are countries that seem to have limited awareness of, and engagement with, future technologies. Low levels of awareness, and limited knowledge and skills in new technologies directly correlate with a lack of capacity and preparedness to face future technological disruption. Thus, countries lagging on that front overlook the opportunities and potential positive impacts that future technologies can have on day-to-day activities and society as a whole. Several Arab and African countries have been found to be on the lower end of technological uptake, compared to developed countries elsewhere.

Figure 1.1: Country grouping based on the Global Knowledge Index (GKI) 2019 and Global Technology Awareness Index 2019



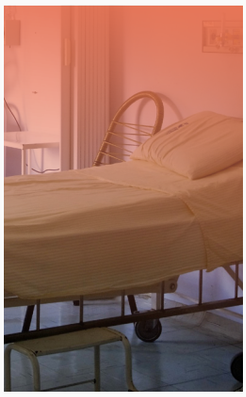
Green Grouping: Low GKI and a low Global Technology Awareness Index
Black Grouping: Moderate GKI and Global Technology Awareness Index
Red Grouping: Very solid GKI and robust Global Technology Awareness Index
Blue Grouping: Strongest performance on the GKI and the Global Technology Awareness Index

Source: UNDP and MBRF, 2019b.

According to the Future of Knowledge Foresight Reports of 2018 and 2019, economies are not prepared for future disruptions and their knowledge ecosystems are not sufficiently well-established to absorb potential future risks. This failure or delay in realizing their ultimate potential is a missed opportunity for these countries, as new technologies play an increasingly important role in our lives that goes beyond economic development. The COVID-19 pandemic revealed the fragility of economies and their lack of capacity to respond to unanticipated disruptions. The pandemic affected all countries, regardless of the knowledge dimensions one looks at – albeit to varying degrees, depending on a country's level of preparedness and capacities. This global health crisis constituted a major disruption for every nation, with deep impacts on all layers of society, with effects on aspects ranging from the economy and the environment to well-being and the digital equality between individuals. It has shed light not only on the urgency for collaboration between countries, but also on the deep-rooted relationship between our natural and societal systems, whereby systems – whether they relate to the economic, political, social or environmental arena – to a large extent determine countries' societal resilience.[8] More importantly, in the context of the present report, the COVID-19 crisis highlighted the need for collaborative and innovative approaches to address such disruptions in an attempt to build more resilient and inclusive nations.

Box 1.1: COVID-19 global impact

The examples below are meant to be illustrative and only include selected severe COVID-19-related impacts.



Health impacts

The health impacts of COVID-19 have been immense, with 217,037,300 confirmed cases globally, including 4,510,304 deaths, as reported to the World Health Organization (WHO) by 31 August 2021.[1] Both in developed and developing countries, health systems were, in varying degrees, incapable of responding to the pandemic. This reflects several shortcomings and gaps related to capacities, infrastructure and investment in the health care sector. The latter placed a significant burden on the front-line health care workforce battling the pandemic with limited resources, affecting their mental and physical well-being and exposing them to high levels of risk. Also, some high-risk patients abstained from visiting hospitals and clinics and postponed regular check-ups and scheduled procedures.[2] The gains made by a number of countries in improving health outcomes were jeopardized. The development of a vaccine, in response to the pandemic, has also led to challenges around maintaining research and development (R&D) incentives, running clinical trials, authorizations, post-market surveillance, manufacturing and supply, global dissemination, allocation, uptake and clinical system adaption.[3]

Economic impacts

According to the International Monetary Fund (IMF) estimates,[4] "the cumulative per capita income losses over 2020–2022, compared to pre-pandemic projections, are equivalent to 20 percent of 2019 per capita gross domestic product (GDP) in emerging markets and developing economies (excluding China), while in advanced economies the losses are expected to be relatively smaller, at 11 percent". Thus, this 'Great Lockdown' represents the biggest global recession since the Great Depression,[5] whereby real GDP growth shrunk by 3.3 percent in 2020.[6] In the Arab region, the economic impact of the COVID-19 pandemic in 2020 was severe, with a GDP contraction of 4.2 percent.[7] Due to stringent lockdown measures adopted by governments globally in an attempt to limit the spread of COVID-19, the flow of raw materials and finished goods was impaired, thereby disrupting global supply chains. The COVID-19 pandemic reversed the efforts towards alleviating poverty by 2030, as the World Bank projects that 150 million people will have entered the ranks of extreme poverty by the end of 2021.[8] In the Arab region, 9.1 million people will be pushed into poverty due to COVID-19, increasing the number of people classified as poor to around 116 million in 2021.[9] At the individual level, the COVID-19 pandemic is expected to affect vulnerable groups such as young workers (particularly women) as well as those with lower skill levels, more severely, thus proliferating existing inequalities.[10]

Environmental impacts

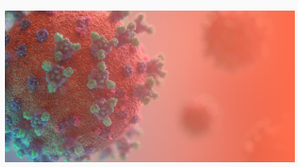
Following the strict global lockdown measures, a positive impact on the natural environment was observed. The slowdown in economic activity and travel bans, along with limited land transportation, led to a reduction in GHG emissions and noise pollution, an improvement in water and air quality, as well as a restoration of wildlife. For instance, the International Energy Agency (IEA) recorded a total decline in global CO_2 emissions of 5.8 percent in 2020 – the largest annual decline since World War II. However, it is important to note that concentrations of CO_2 in the Earth's atmosphere have kept on rising, and CO_2 emissions are expected to rebound in 2021 as energy demand rises.[11] Furthermore, as the quantity of suspended particulate matter[12] in water decreased, improvements in water quality were witnessed.[13] Moreover, the pandemic has provided an opportunity for households to rethink their shopping patterns and many expressed an increased desire to make 'eco-friendly' and sustainable choices in their purchases. One in three consumers ranked sustainability among the top three purchasing criteria.[14] However, although consumers express a greater appetite for making more sustainable choices, it remains less clear to what extent these stated preferences will result in changed behaviour concerning different product and service choices. Hence, the private and public sectors now have a golden opportunity to reassess their production and consumption patterns and introduce sustainable and innovative solutions that contribute towards a more sustainable future.

Notes: 1.WHO, n.d.-b; **2.** Deloitte, 2020; **3.** Forman and others, 2021; **4.** IMF, 2021c; **5.** IMF, 2020; **6.** IMF, 2021d; **7.** IMF, 2021b; **8.** World Bank, 2020b; **9.** ESCWA, 2020; **10.** See McKinsey & Company, 2021; **11.** International Energy Agency, 2021; **12.** According to the Organisation for Economic Co-operation and Development, suspended particulate matter (SPM) are finely divided solids or liquids that may be dispersed through the air from combustion processes, industrial activities or natural sources; **13.** Aman, 2020; **14.** Accenture, 2020.

In addition to causing global disruption, the COVID-19 pandemic has greatly impacted the progress of countries in meeting the 2030 Agenda for Sustainable Development.[9] Recent studies show that the gains made toward the Sustainable Development Goals (SDGs) – e.g. the remarkable decrease in infant and maternal mortality rates,[10] HIV/AIDS and malaria related deaths[11] and the efforts towards bridging the digital divide[12] – are now under threat. Moreover, COVID-19 has revealed a unique and "new pattern of interconnectedness between SDGs."[13] The pandemic greatly affected the SDGs related to health, which in turn affected education, climate change, economic growth and consumption and production. It triggered an especially negative spillover effect on goals related to equality, innovation and infrastructure, cities and communities, and partnerships.[14] The United Nations Development Programme (UNDP) assessed the impact of COVID-19 on the SDGs in collaboration with the Frederick S. Pardee Center for International Futures at the University of Denver and concluded that the severe long-term effects of the pandemic could be mitigated through integrated SDG investments to help governments enhance their effectiveness and efficiency, and citizens revisit their consumption patterns.[15]

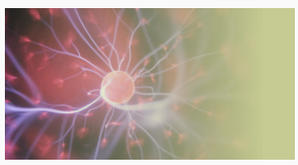
While the COVID-19 pandemic impacted all countries, some were more affected than others, depending on their capacities (or preparedness) to respond to this health crisis. To better understand these differences, UNDP has put together a set of indicators in an interactive dashboard reflecting the level of preparedness and vulnerability of countries in responding to, and coping with, the repercussions of the pandemic.[16] The data assesses preparedness from three main perspectives: level of development; health system capacity; and Internet connectivity.[17] The data reveals visible disparities between very high human development countries and low human development countries. While very high human development countries benefit from an average of 30.4 physicians, 81 nurses and midwives, and 55 hospital beds per 10,000 people, low human development countries have an average of 2.1 physicians, 8 nurses and midwives and 6 hospital beds per 10,000 people. The limited health care capacity in low human development countries, coupled with restricted levels of connectivity and high levels of inequality, aggravated the effects of the pandemic on the socioeconomic landscape.[18] Singapore, a country with very high human development, is often quoted among the leaders in the containment of the spread of the virus, limiting the number of COVID-19 related deaths to a great extent. As of May 2021, the ratio of COVID-19 deaths to COVID-19 cases in Singapore stood at 0.05 percent, against a global average of 2.13 percent.[19] Awareness of epidemic risks, infrastructure capacities, innovation,[20] collaboration and other factors help explain why Singapore was able to effectively respond to the COVID-19 crisis (see Box 1.2).

Box 1.2: The example of Singapore and its capacities in responding to the COVID-19 pandemic



Awareness of epidemic risks: Singapore suffered from several infectious disease outbreaks, including SARS (2002), H1N1 (2009) and Zika (2016). As a result, the government as well as its citizens were aware of health risks relating to infectious diseases, which helped them to quickly understand the need for rapid and extensive measures for containing the emerging COVID-19 pandemic. This helps explain why Singapore put in place safety measures so soon after the WHO announced the Wuhan outbreak on 31 December 2019.[1]

Infrastructure capacities: health care capacities were also important - Singapore was already a medical tourism hub for several neighbouring countries. As a result, the country's health care system is characterized by numerous hospitals and high-quality public health care facilities. During the COVID-19 pandemic, the health authorities invested in additional bed capacity for patients to limit the spread of the virus.[2]



Innovation: as highlighted by a recent UNDP study, Singapore's ability to design and implement (digital) innovation was key to responding to the COVID-19 pandemic. For instance, a website, built through cooperation between government ministries, helped the population identify the location, day and time to collect masks allocated by the Government. Another example relates to WhatsApp, which was used as one of the communication channels to inform citizens about the latest information on COVID-19.[3]

Collaboration: the government set up a multi-ministry taskforce to coordinate its COVID-19 response. This taskforce includes, inter alia, members of the Ministry of Health, National Development and Education, highlighting the need for building partnerships across government institutions. Partnerships were also built with the private sector, where private clinics deployed doctors, nurses and other medical staff to support public COVID-19 initiatives.[4]

Notes: 1. Tan and others, 2021; **2.** UNDP, n.d.-c; **3.** Reuters, 2020; **4.** Rees, 2020.

Globalization dynamics have amplified the disruptions created by COVID-19 and compounded the likelihood of global risks. For example, economists such as Stiglitz[21] and Piketty[22] associate globalization with an increase in wealth and income inequalities. Aside from its economic impacts, a growing body of research is studying the effects of globalization on development as it generates disruption and risks to the environment[23] and human health.[24] This includes the unprecedented effect of technological disruption on our lives. Studies have found that global interconnectedness between economic, social and environmental systems increase the complexity of addressing both local and global challenges. They also reveal the need for radical transformation based on collaborative and innovative approaches and practices.

1.2 PURPOSE AND OBJECTIVES

While the 2018 and 2019 Future of Knowledge Foresight Reports questioned countries' ability and readiness to embark on the foreseen future knowledge trajectory, the 2019–2021 period has posed more structural questions regarding countries' ability to weather external risks.

This report aims to support responsible national leadership to ensure preparedness to address future global risks. Building upon the two earlier editions of the Future of Knowledge reports, this edition explores how countries leverage their transformative capacities (collaborative and innovative) to deal with major global risks and disruptions that societies are facing—namely, health, environmental and technological risks. The report looks at collaborative and innovative capacities from knowledge-based and skill-based perspectives, reflecting on various dimensions of the Global Knowledge Index (GKI)[25] and the future of skills. Such a study provides a better understanding of how countries prepare their respective labour forces for the future of work. Equipping the labour force with the skills of the future has been identified as a way to accelerate an effective response to the impacts brought on by the COVID-19 pandemic[26] and to increase the resilience of countries against global risks.

Box 1.3: The Global Knowledge Index

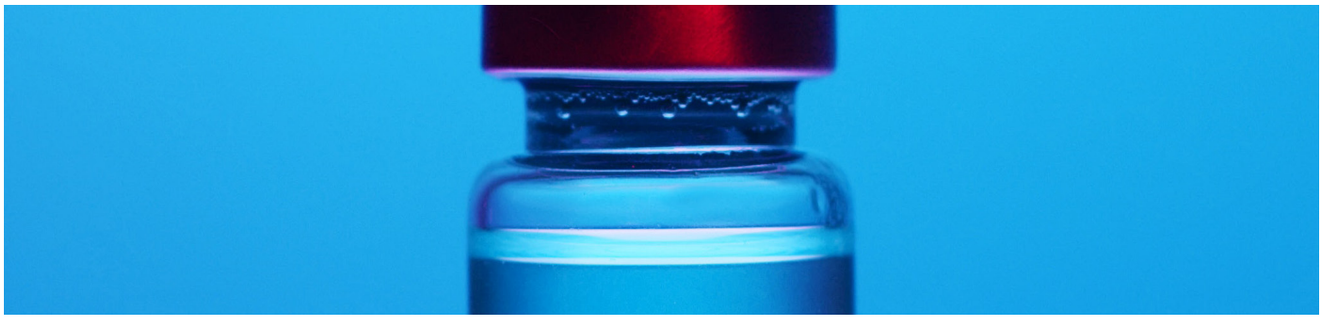
The Global Knowledge Index (GKI) is a roadmap for the sustainable development of societies. It helps countries formulate forward-thinking strategies to support knowledge and promote it as a key component of building a stronger knowledge economy, while also ensuring sustainable development.

The GKI aims to measure knowledge, as a broad concept that intricately relates to all aspects of modern human life, in a systematic approach that builds on solid conceptual and methodological principles. It comprises seven sectoral indices covering: pre-university education; technical and vocational education and training (TVET); higher education; research, development and innovation (RDI); information and communications technology (ICT); economy; and general enabling environment.

Source: UNDP and MBRF, 2017.

This report investigates the transformative capacities of countries, based on their awareness of the aforementioned risks and capacities, captured through online and social media analytics across countries and time. Social media is often used during disasters as a platform to share information relating to crisis management and the coordination of response and disaster resilience learning.[27] In the case of the COVID-19 crisis, both Abdul-Baki[28] and Alnasser[29] have found that social media had a positive impact on information dissemination relating to the pandemic in the Arab region.[30] This report adds to the existing literature by providing unique and real-time data on the degree of awareness of countries of future risks, as well as knowledge and skills aspects.

The report consists of four chapters. **Chapter 1** further illustrates the global, health environmental and technological risks, and the challenges they pose. It also provides an analysis of the role of transformative capacity for withstanding these risks, and the key knowledge and skills dimensions that provide the foundation for such a transformation to occur. **Chapter 2** presents the methodological approach employed to carry out the analysis – reflecting on data collection tools, analytical framework and approach. **Chapter 3** focuses on the key findings of the analysis at the global level in terms of collaborative and innovative capacities. **Chapter 4** presents a set of recommendations and concluding remarks.



1.3 GLOBAL RISKS

The United Nations Office for Disaster Risk Reduction (UNDRR) defines a risk as "the probability of an outcome having a negative effect on people, systems or assets".[31] Risks are characterized by the following determinants: hazard, exposure and vulnerability.[32]

Box 1.4: Determinants of risk: exposure and vulnerability

Hazard refers to the possible, future occurrence of natural or human-induced physical events that may have adverse effects on vulnerable and exposed elements.

Exposure refers to the inventory of elements in an area in which hazard events may occur.

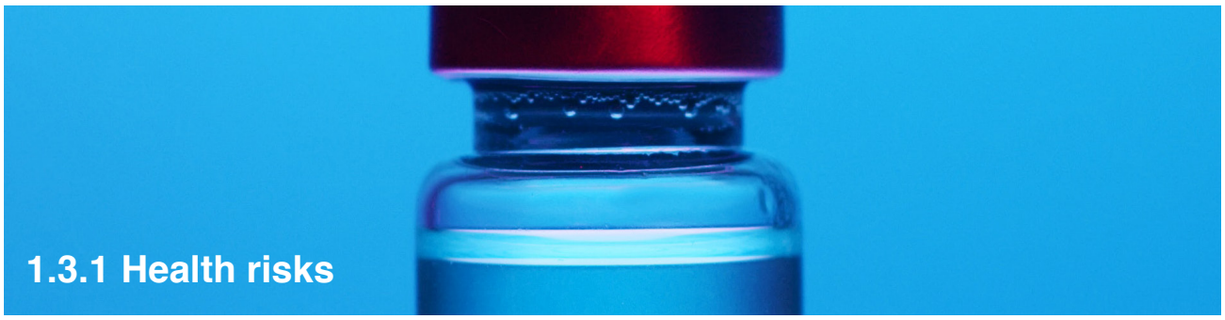
Vulnerability refers to the propensity of exposed elements such as human beings, their livelihoods and assets to suffer adverse effects when impacted by hazardous events.

Source: Cardona and others, 2012.

This report focuses on health, environmental and technological risks as the most significant current and future risks in terms of likelihood and impact.[33] These risks include, among others, infectious diseases, climate change, biodiversity loss, cyberattacks, data fraud and digital inequality. All these risks are interconnected (e.g. failure to counteract climate change affects biodiversity loss, which may affect the spread of zoonotic infectious diseases) and are global, affecting all societies in each part of the world—albeit to a different extent (among nations and within a county's borders). In other words, these risks pose a threat to societal progress towards sustainable development. Reducing and mitigating these risks requires a holistic and inclusive response, as the effects of these threats are not solely observed by the countries that are causing them but also by those that are not. While high- and upper-middle-income countries contribute to most CO_2 emissions (around 86 percent of global emissions),[34] low- and lower-middle-income countries end up having to respond to the consequent impacts at a relatively higher price, given their limited resources and capacities.

of CO_2 emissions are emitted by rich countries

As learning is an ongoing process and lessons learnt can be easily transposed from one crisis (challenge) to another, countries should aim to design a 'learning from crises' framework that supports risk-informed investments and long-term societal and economic resilience.



1.3.1 Health risks

Progress achieved in the fields of nutrition, treatment, vaccines, health care technologies, etc. has helped combat several leading causes of death and disease, contributing to better global health.[35] As health systems have improved, global average life expectancy has more than doubled since the 1900s, and quality of life has significantly increased.[36] This has contributed to an expansion of the global labour force and its productivity, showing that health is a key component for sustainable development, with a significant impact on both the economy of countries and the well-being of their citizens.[37]

$2-4 **Potential economic return from investing $1 in better health.[38]**

Despite the progress achieved over the past century, health risks continue to present a threat to economic prosperity and societal well-being, as demonstrated by the COVID-19 pandemic. In practice, health threats negatively impact education, income and life expectancy, reduce productivity and aggravate poverty, thus impeding human development. For example, studies have shown that patients lose, on average, three to four months of worktime once diagnosed with tuberculosis, affecting 20 to 30 percent of annual household income.[39] For governments, health risks also come with an increase in health care spending and reduced economic growth. Moreover, health threats can also potentially generate social fragmentation, exacerbate further inequities and lead to political destabilization. This was evident during the pandemic, with the surge of protests in response to the strict measures imposed by governments to limit the spread of COVID-19 in countries like Spain, Lebanon and the United States. It is therefore imperative for leaders to ensure that their countries are prepared to tackle health risks and their impacts on society, given the interconnectedness of health with other social and economic aspects of the society.

In the present report, the definition of health risks, based on SDG 3 'Good Health and Well-Being',[40] focuses on communicable diseases, non-communicable diseases and mental health, as well as health risk factors and health care capacities—as reflected in the Goal 3 targets. Notably, WHO highlights these conditions and capacities as global health issues to be tracked in 2021.[41]

1.3.1.1 Communicable diseases

Communicable diseases, also referred to as infectious diseases, are "caused by pathogenic microorganisms, such as bacteria, viruses, parasites or fungi; the diseases can be spread, directly or indirectly, from one person to another."[42] Infectious diseases notably include HIV/AIDS, hepatitis, Ebola and diphtheria. They kill about eight million people annually, over one third of which never reach their 20th birthday,[43] and are ranked by the *Global Risks Report 2021* among the highest impact risks of the next decade.[44] Despite all efforts for improvement in treating communicable diseases in low-income countries, 6 out of the top 10 causes of death are communicable diseases; thus it is more likely that people in these countries die of a communicable disease than a non-communicable disease.[45]

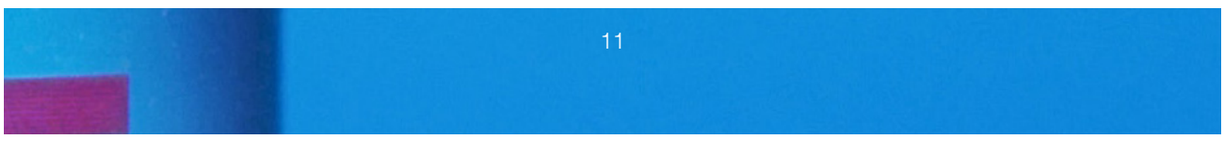
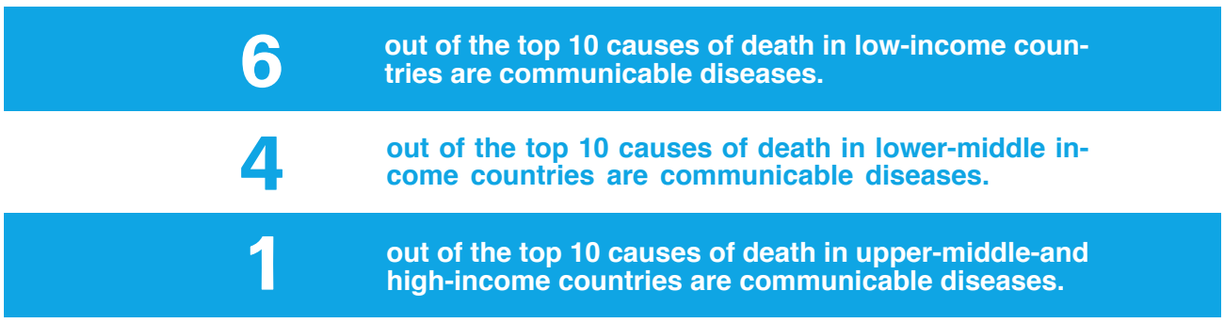


Figure 1.2: Communicable diseases as top causes of death in 2019



Source: WHO, 2020c.

The causes of infectious diseases often lie outside the direct control of the health sector and rather result from socioeconomic, environmental and behavioural factors such as issues of sanitation and water supply, human population growth, environmental challenges, land use change and climate change, as well as increases in international trade, tourism, transport, industrial development and housing. The Eastern Mediterranean region[46] continues to be a hotspot for emerging and re-emerging infectious diseases, as many risk factors contribute to the emergence and rapid spread of communicable diseases, including acute and protracted humanitarian emergencies. These risk factors include, *inter alia*, rapid urbanization (in many instances leading to biodiversity loss) that increases the number of interactions between humans and animals; limited health care capacities that impede countries' preparedness to respond to infectious diseases; and increasing migration (whether climate- or conflict-related) in the region.[47]

Communicable diseases that turn into epidemics or pandemics can cause major global disruptions.[48] Given the increased economic reliance on international connectivity through travel and trade networks, pandemic risk is rising over time, along with the related harm it engenders.[49] As evidenced by the COVID-19 pandemic, communicable diseases can overwhelm the capacity of countries to respond to epidemics and pandemics and can consequently lead to serious health and socioeconomic consequences, costing tens of billions of dollars. In pandemics or epidemics, avoiding further infections necessarily means limiting contact among citizens, thus greatly impacting, *inter alia*, business activities and the public sector's ability to provide services to citizens (education, health or general processes such as granting building permits). Beyond the national scope, these limitations may also translate into a trade reduction between countries.[50] Moreover, a sizeable outbreak can put the health system under great pressure, limiting the capacity to deal with other routine health issues and thereby compounding the stress on the system. Communicable diseases, when turning into epidemics or pandemics, can even lead to growing inequalities, as lower earners accumulate more aggregate debt when their income falls to spend on necessities and maintain the same spending, unlike top earners who are already consuming near maximum capacity.[51]

Despite the prominent risk that communicable diseases present, they are preventable and treatable to a great extent. Preventive measures can include, notably, immunization through vaccination, reduced household air pollution, safe drinking water, proper sanitation and hygiene. Rapid detection of cases of epidemic prone diseases through surveillance systems is another essential measure in curbing the spread of communicable diseases.

1.3.1.2 Non-communicable diseases (NCDs)

Non-communicable diseases are the leading global public health challenge of the 21st century,[52] creating a significant burden on health systems and a growing economic burden on national economies. NCDs, also known as chronic or lifestyle-related diseases, affect people across all age groups, genders, countries and regions, and are usually the result of genetic, physiological, environmental or behavioural factors, or a combination thereof. They are not infectious to others and usually affect individuals for a long period of time. NCDs is a general name for a broad range of diseases that include, but are not limited to, cardiovascular diseases

(such as heart attacks and strokes), cancers, chronic respiratory diseases, obesity and diabetes. Many factors contribute to the increase in the rates of these diseases, such as rapid unplanned urbanization, which encourages unhealthy lifestyles and diets, low physical activity and smoking. Such lifestyle choices can increase the parameters that are correlated with obesity, which in turn increase the metabolic risk factors for cardiovascular diseases, which is a primary NCD causing thousands of premature deaths.[53]

Killing 41 million people each year, NCDs cause 71 percent of all deaths globally.[54] As of 2019, 7 of the world's top 10 causes of death were NCDs—a sharp increase since 2000, when NCDs constituted 4 out of 10 leading causes.[55] These are particularly prominent in upper-middle- and high-income countries, causing over three quarters of health problems.[56] The disease burden attributed to non-communicable diseases among lower-middle-income countries accounted for nearly two thirds of the overall disease burden in 2019, up from one third in 1990,[57]and is more likely to affect younger people and exhaust fragile health systems.[58] In Uzbekistan and the Philippines, for example, the number of deaths caused by diabetes and ischaemic heart disease have risen by 600 percent and 350 percent, respectively.[59] Likewise, countries in the Gulf and the Eastern Mediterranean Region show a worrying increase in new cancer cases, with long-term projections of a 1.8-fold rise in cancer incidence by 2030.[60]

41 MILLION

deaths every year from NCDs.

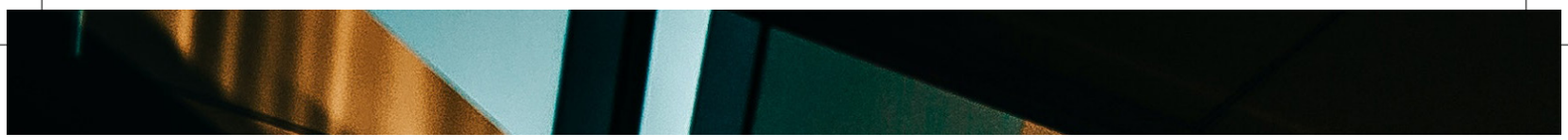
A large part of the burden caused by non-communicable diseases can be prevented, notably through early diagnosis and detection and mainly by controlling underlying determinants and risk factors, such as tobacco use, unhealthy diets, physical inactivity and harmful use of alcohol.[61] While there have been advances in battling communicable diseases, there has been inadequate progress in preventing and controlling premature death from non-communicable diseases.

1.3.1.3 Health risk factors

Despite countries investing more in health care every year, there has been a significant and alarming increase (over 0.5 percent per year globally) in exposure to highly preventable risk factors—such as obesity, high blood sugar, alcohol use and drug use—which are contributing to the growing burden of NCDs.[62] NCDs generated by these risk factors not only affect health, but also affect the economy, and therefore impede the sustainable development of countries. For example, life expectancy across the Organisation for Economic Co-operation and Development (OECD), European Union (EU) and G20 countries is expected to fall by three years by 2050 as a result of obesity and related diseases. Collectively, it would cost the economies and health care systems of these countries an additional $425 billion a year to treat the resulting diseases.[63]

45% **of deaths among children under 5 years of age are due to forms of malnutrition in low- and middle-income countries.**

While micronutrient-related malnutrition can lead to obesity, undernutrition constitutes another form of malnutrition, which is the cause of 45 percent of deaths among children under the age of five, mostly occurring in low- and middle-income countries.[64] Preventable communicable diseases, such as diarrhoea, malaria, and poor child and maternal health, continue to pose a substantial threat to citizens in low- and middle-income countries. Infectious, maternal and neonatal disease mortality accounts for more than 52 percent of the total disease burden, contributing to a child mortality rate 16 times higher than in high-income countries. Despite significant improvements most low- and middle-income countries have made, the life expectancy gap with high-income nations remains high, standing at about 16 years lower for low-income countries, and 10 years lower for middle-income countries.[65]



1.3.1.4 Health care capacities

Health care systems play a role in preventing exposure to health risk factors, detecting diseases at early stages and curing diseases. The assessment of the quality of health systems is based on the extent to which services offered to individuals and patient populations achieve the desired health outcomes.[66] The availability, accessibility, acceptability and quality of health care are all key factors in increasing health service coverage and health standards.[67] Health care quality includes having sufficient health care facilities (such as hospitals and clinics), ensuring health care professionals are properly trained, and obtaining the right equipment to work efficiently. In this regard, WHO points to a labour and skills shortage among health workers, which is predicted to reach 18 million personnel worldwide by 2030, mostly in low- and lower-middle-income countries. This is applicable to all countries, at different levels and degrees: from the education to the employment, performance and retention of their health care workforce. This issue is expected to weigh heavily on countries, threatening their resilience and preparedness to respond to future health risks.[68]

In some regions, the weakness of the health systems coupled with socioeconomic factors impede the coverage of the health system. More than 1.6 billion people (22 percent of the global population) live in countries facing protracted crises, suffering issues of access to health care and weak health services. Consequently, these countries face discernible health inequalities.[69]

More than 1.6 billion people (22% of the global population) are left without access to basic care due to protracted crises.

There are significant sociodemographic inequalities in health risk factors and health outcomes both between and within countries. These are driven by issues such as income, gender, ethnicity, living in remote rural areas or disadvantaged urban areas, education, occupation/employment conditions, and disability. Thus, people living in poor areas tend to have limited access to quality health care, leading to worse health outcomes, a reduction in economic participation and productivity, and an increase in economic vulnerability.[70] It is therefore a matter of social justice for policymakers to understand the underlying inequities when developing strategies aimed at improving the health system.

1.3.2 Environmental risks

Providing a decent life and well-being for a growing world population without compromising the environment and ecological limit of our planet is one of the greatest challenges of our time.[71] Over the past few decades, human activities have transformed "the Earth's natural systems, exceeding their capacity and disrupting their self-regulatory mechanisms, with irreversible consequences."[72] The so-called 'Earth Overshoot Day' marks the date when mankind's consumption of ecological resources for the year surpasses that which the Earth can regenerate in that year. In 2021, it fell on 29 July. The date has become earlier over the last two decades, as evidenced by the fact that Earth Overshoot Day was 8 August in 2010 and 23 September in 2000.[73] The end of the climatic stability of the Holocene period, in which predictable conditions allowed humans to settle, farm and build civilizations, is expected to have a catastrophic effect on societies. Moreover, biodiversity loss is accelerating, as illustrated by the drop in numbers of species, populations and varieties of plants and animals.[74] Importantly, these phenomena have a differentiated impact depending on the countries they affect and may exacerbate long existing inequalities.

While environmental impacts used to be studied in isolation of other trends and issues, more and more research and policies take an integrated and holistic approach to the topic. This is the case for the 2030 Agenda, an integrated and balanced plan of action, which dedicates one of the SDGs to climate action, but also includes environmental dimensions across a large part of the SDGs (for instance, including SDG 6, clean water and sanitation; 7, affordable and clean energy; 12, responsible consumption and production; 14, life below water; 15, life on land; and 17, partnerships for the goals).[75] Environmental risks are connected to other facets (including social and economic development) and can affect the extent to which development takes place, as described in Figure 1.3. As mentioned above, this connectedness and its interlinkages became even more evident during the COVID-19 pandemic. For instance, several research papers point to the "risk of novel zoonotic diseases rises with the loss of biodiversity until an intermediate level of biodiversity loss is reached."[76] The research links health risks directly to environmental risks. By the same token, economic risks arise with environmental disruptions. Studies estimate that the costs of pollution to the global economy amount to $4.6 trillion per year, which is equivalent to 6.2 percent of global economic output.[77]

Over time, the focus has moved from environmental conservation and preservation to economic concerns. Even more recently, the focus shifted to the threat that environmental degradation poses to human health and well-being.[78] There are major concerns about the reversal of gains in life expectancy and well-being since the industrial revolution, which are partly driven by the increasing presence of environmental risks. Climate change has a considerable impact on the global economy, with global GDP at risk of falling by as much as 18 percent if no mitigating actions are taken by 2050.[79] This has also triggered international institutions such as the IMF to take measures to support the fight against climate change by actively playing a role in integrating climate change in the financial systems of countries and promoting a green recovery by proposing an international carbon floor and reporting for climate-related financial risks, and advocating green taxonomy.[80]

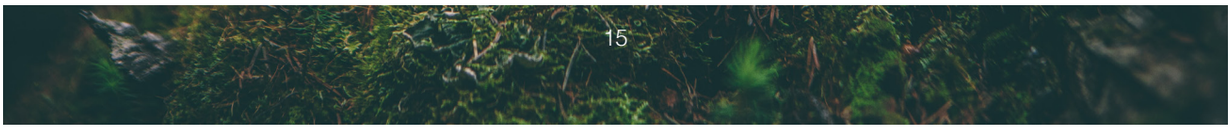
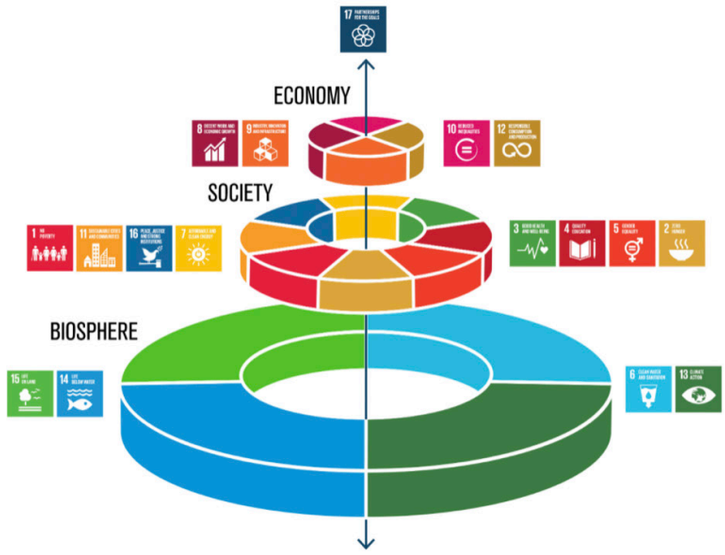


Figure 1.3: Economies and societies as embedded parts of the biosphere

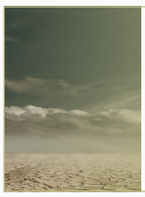


Source: Stockholm Resilience Centre, 2016.

Environmental risks are considered among the most critical global risks for humanity.[81] The *Global Risks Report 2021* identifies environmental risks such as extreme weather and human environment damage as clear and present dangers that may lead to biodiversity loss, natural resource crises and climate action failure. Additionally, it is anticipated that four out of the top seven most prominently felt impact risks in 2021 to be environmental.[82] These risks are partly driven by a growing population, economic development, technology and climate change. It is therefore of prime importance for countries to be aware of, and to prepare and strengthen their capacities to deal with, environmental risks. These specific risks are also echoed in the recent update of the medium-term strategy (2022–2025) of the United Nations Environment Programme (UNEP). The strategy focuses on climate change, biodiversity loss and pollution as the three planetary (and interconnected) crises or risks affecting our relationship with the natural world and jeopardizing global economic and social well-being.[83]

Box 1.5: Definition of selected environmental risks

UNEP defines **biodiversity** loss as the irrevocable and continuing decline of genetic and species diversity, and the degradation of ecosystems at local and global scales.[1]



Climate change refers to "a change in the state of the climate that can be identified (e.g. by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forces such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use."[2]

Pollution is defined as the presence of substances and heat in environmental media (air, water, land) whose nature, location, or quantity produces undesirable environmental effects.[3]

Notes: 1. UNEP, 2019; **2.** IPCC, 2018; **3.** See UNSD, 1997.

1.3.2.1 Climate change

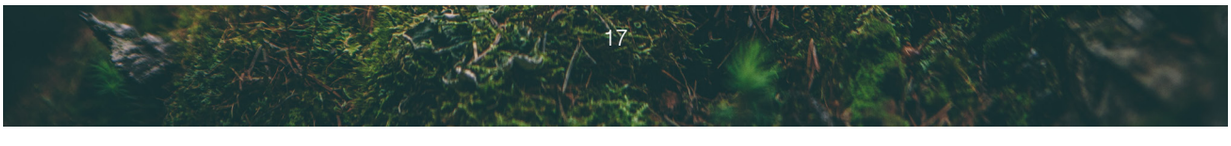
The climate emergency is now described as "the defining issue of our time", affecting all aspects of life from food security, natural resources to migration patterns that are escalating tensions across countries.[84] Climate change is no longer a matter of discussion within the scientific community, but rather an emergency that needs to be dealt with immediately. In view of the magnitude of the problem, the solution requires international collaboration, namely the negotiation of rules accepted by a large number of countries. Involving many different actors to deal with the scale of the phenomenon also means that decision-making is becoming more complex. Each country will have differing interests and its own specific situations to consider. In 1992, the international community joined forces to adopt the United Nations Framework Convention on Climate Change (UNFCCC).[85] This was followed by the Kyoto Protocol,[86] adopted in 1997, which committed state parties to reducing GHG emissions, while differentiating between each party's obligation based on their level of development. The more recent Paris Agreement[87] that entered into force in 2016, is the first universal agreement concerning climate change that obliges all countries to participate in the reduction of greenhouse gas emissions and the limiting of global warming, no matter their development level. In the Paris Agreement, countries agreed on "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change."[88] This target appears to be challenging to reach, as the world is heading for a temperature rise beyond 3°C this century—well out of step with the Paris Agreement goals.[89]

Latest evidence[90] shows that: i) despite the COVID-19 pandemic and the related global decline in emissions, the concentrations of major GHGs continued to increase; ii) 2020 was one of the three warmest years on record; iii) the trends reveal that the sea level rise is accelerating and ocean heat storage and acidification are increasing; iv) the Arctic minimum sea-ice extent in September 2020 was the second lowest on record; and v) about 9.8 million people were displaced because of climate hazards and disasters during the first of half of 2020.[91] These impacts vary according to regions, countries and within countries. For instance, as of 2019, the Arab States region contained 10[92] of the world's 20 most water-stressed countries and is, hence, particularly affected by climate change and disasters.[93] The changes observed in the climate system are also likely to increase disaster risks by changing hazard patterns and exacerbating drivers of vulnerability.[94,95]

Economic damage from climate change will reach $1.7 trillion per year by 2025 and roughly $30 trillion per year (5 percent of projected GDP) by 2075 if the current warming trend continues.[96]

The World Bank stresses that climate change impacts are expected to push between 68 million and 132 million people into poverty over the next decade, reversing previously achieved development gains.[97] It is also expected to have a major impact on food security, with Intergovernmental Panel on Climate Change (IPCC) forecasts projecting a 1–29 percent cereal price increase in 2050 due to climate change, which would impact - particularly low-income and poor - consumers through higher food prices; and a 1–183 million additional people at risk of hunger compared to a no climate change scenario.[98]

In the past two decades, policymakers – sometimes in collaboration with the private sector and civil society – have started building up their capacities with the aim of reducing climate change and its impacts. Capacities and awareness[99] are key attributes of climate-resilient pathways, in addition to resources and practices.[100] Moving from theory to practice, governments and institutions have developed strategies, schemes and action plans to ensure that effective risk management and adaptation is implemented and sustained. In practice, these may take the shape of climate adaptation and mitigation measures, as well as Nature-Based Climate Solutions[101] or carbon-neutral solutions. Solutions can be combined or integrated so that each benefits from progress of the other.



1.3.2.2 Biodiversity loss and natural resources

Biodiversity loss stood in fifth and fourth place in the World Economic Forum's *Global Risks Report 2021*, in regard to its likelihood and impact, respectively.[102] There is a general recognition that nature and biodiversity (including species, ecological and evolutionary processes, as well as landscapes and ecosystems) is declining rapidly. Box 1.6, extracted from the latest Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) report, shows some of the key statistics demonstrating biodiversity loss.

Box 1.6: Biodiversity loss in numbers – selected examples

Species, populations and varieties of plants and animals

- Tens to hundreds of times: the extent to which the global rate of species extinction is higher compared to the average rate over the last 10 million years. The rate is accelerating.
- Up to 1 million: species threatened with extinction, many within decades.
- >500,000 (+/-9 percent): share of the world's estimated 5.9 million terrestrial species with insufficient habitat for long-tersurvival without habitat restoration.

Oceans and fishing

- 33 percent of marine fish stocks overfished in 2015; 60 percent are maximally sustainably fished; 7 percent are underfished.
- 3–25 percent: projected decrease in fish biomass by the end of the century in low and high climate warming scenarios, respectively.
- 100–300 million: people in coastal areas at increased risk due to loss of coastal habitat protection.

Forests

- 50 percent: agricultural expansion that occurred at the expense of forests.
- 68 percent: global forest area today compared with the estimated pre-industrial level.
- 290 million ha (+/-6 percent): native forest cover lost from 1990 to 2015 due to clearing and wood harvesting.
- 10–15 percent: global timber supplies provided by illegal forestry (up to 50 percent in some areas).

Source: Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, 2019.

Consequently, biodiversity loss has an impact on the achievement of the SDGs. For example, as previously noted, biodiversity, and good health and well-being (SDG 3), are increasingly recognized as connected, as the achievement of one relies on the achievement of the other. Biodiversity helps mitigate water, air and land pollution. Biodiversity is also a source of energy (SDG 7) and supports the delivery of water supplies, water quality, and at the same time protects against water-related disasters (SDG 6).

Several actors, ranging from policymakers to civil society to the private sector, are implementing policies, practices and actions in order to protect biodiversity and prevent further degradation. These include, *inter alia*, protected areas and managed areas with conservation targets; national green accounting; and investments in natural capital or environmental regulation, standards and certification. In turn, this may help countries respond to future biodiversity loss risks in the short term. The EU, for example, established its own Emissions Trading System (EU ETS), which was the world's first large carbon market. The EU regulates carbon emissions through the ETS, which places a price on carbon emissions and makes pollution less appealing to regulated businesses.[103]

1.3.2.3 Pollution

Pollution, which includes air, water (marine and freshwater), and land and soil pollution, has been increasing over the last few decades, and is qualified as "pervasive and persistent" by the UNEP.[104] The causes of pollution are diverse and can include, *inter alia*, the combustion of fossil fuels from the energy sector; or chemicals and extractives from the manufacturing industry. This can even extend to information technology, construction, homebuilding and building products that all include potentially polluting manufacturing processes.

The consequences of pollution are numerous and diverse, severely impacting the development level of countries. For instance, 4.2 million persons die every year due to exposure to ambient (outdoor) air pollution;[105] "57 million years of life are lost or living with a disability annually due to poor water, sanitation, hygiene," etc.[106] The impacts not only affect human health but also biodiversity (where marine pollution caused close to 500 'dead zones', where there is too little oxygen to support marine organisms).[107] It is clear that pollution has a widespread impact and an immense cost. In the Eastern Mediterranean Region,[108] air pollution is estimated to kill about 500,000 people annually.[109]

Figure 1.4: Global costs of pollution in 2015

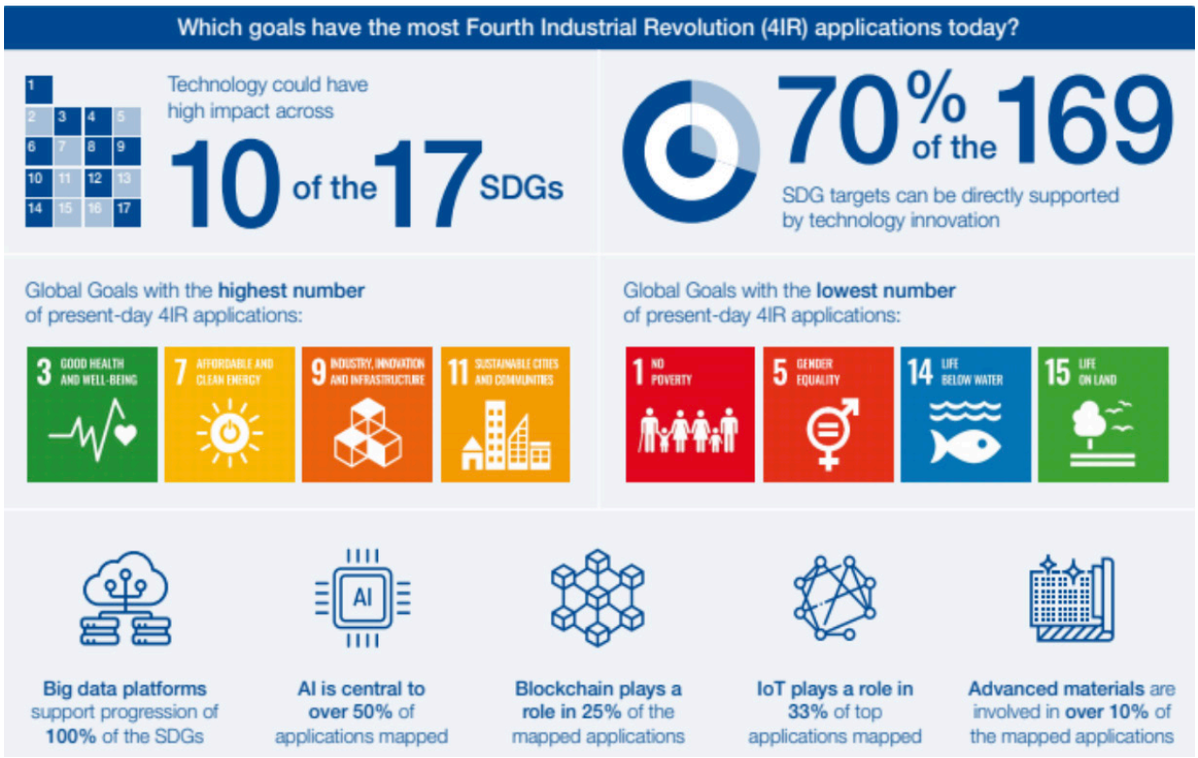
Source: UNEP, 2017.

Solutions exist to tackle the issue of pollution, with several global and regional environmental agreements and national regulations; initiatives targeting pollutants or polluted areas; and systemic changes to the economic system. By integrating circular economy principles into economic sectors, promoting green/clean technologies, reorienting finance and investment and influencing consumer behaviour, major progress can be achieved. All such initiatives could contribute to countries' sustainable development. Tackling pollution would also require building partnerships at the global, regional and national levels.

1.3.3 Technological risks

Emerging technologies present a potentially powerful means of accelerating progress on SDGs. New disruptive technologies offer instantaneous and practical solutions to global challenges with greater speed and accuracy, with a potential impact across about 70 percent of the 169 targets underpinning the SDGs.[110] They can, for instance, increase productivity while maximizing resource and energy efficiency; reduce the cost of goods and services, thereby supporting livelihoods and access to goods (including food); and foster the development of more inclusive forms of participation in social and economic life.[111] In other words, technologies can facilitate the deployment of innovative solutions to address economic, social and environmental challenges, which constitute constraints to development.

Figure 1.5: SDGs and the Fourth Industrial Revolution



Source: WEF, 2020d.

Artificial intelligence (AI) is a great example of the benefits that technologies can offer. AI is increasingly being applied to a wide range of sectors. For example, it is used in the health sector to detect cancer, or to maximize resource and energy efficiency. In these examples, the benefits of AI extend to better health care and quality of life, as well as improved protection of the environment through conservation of natural resources. While new technologies can create opportunities, they can also bring about risks. With more and more systems operating online using various technologies, cybersecurity is becoming increasingly critical. Vital national infrastructures, such as hospitals or energy power stations, need to be protected from cyber threats. The interconnectedness of these technologies with many other societal aspects, makes it clear that fostering the uptake of new technologies is key to tackling not only technological disruptions but also risks relating to the environment, health and safety.

Despite the tremendous positive potential of emerging technologies, they have simultaneously long been considered a source of disruption at all levels, from individual lives and communities to civilizations.[112] Technology adoption encourages new product and process innovation for businesses and impacts the demand for, and supply of, skills; however, it also creates economic, social and environmental disruptions in, areas ranging from the daily tasks of individuals to pronounced competition between global forces.

Figure 1.6: Gartner top strategic technology trends for 2021

Source: Gartner, 2020.

The disruption caused by rapid technological changes produces potential risks such as concentrations of digital power and a widening digital divide. Such risks are ranked sixth and seventh, respectively, as the most likely short-term risks according to the *Global Risks Report 2021*.[113] Rapid technological changes are often unevenly distributed and have the potential to cause digital inequalities within and between countries, women and men, rural and urban populations and rich and poor communities. For example, Internet usage ranges from around 87 percent of the population in developed countries, to less than 20 percent in developing countries. Disparities also exist between urban and rural areas within individual countries, with a large divide between the percentage of households with access to the Internet in cities and towns as compared with the countryside. Globally, statistics show that over two thirds of households in urban areas have access to the Internet, while only 37.7 percent do in rural areas. Data also shows a gender divide in terms of Internet use, with males, on average, exhibiting higher use rates than females.[114] The Internet user gender gap is highest in Africa and the Arab States,[115] which might mean that the local governments of these regions fail to support inclusive growth policies in technological advancement, whether related to ICT access or ICT skills and usage. Another risk to consider relates to gaps in the regulation of technology, its automation, and digital and technological skills and competencies, as digital inclusion efforts are vulnerable to shortfalls. The digital economy is growing at such a fast pace that the potential for the digital gap to widen is high. A growing gap would pose a risk to social cohesion and may disrupt working toward inclusive development.[116]

Rapid technological changes can also raise ethical concerns regarding, for instance, discriminatory algorithms or the unethical use of data. As connectivity facilitates access to information, the use of new technologies increases the possibility for bad actors to use these new sources of information unethically, raising concerns about data privacy, as firms sometimes intensively invest in data collection to later extract private gains.[117] The use of emerging technologies for processing personal data therefore raises a series of questions. Is the data controller (the party that processes the personal data of a data subject) collecting necessary personal data strictly for the purposes for which it is processed? How will this data be processed? Is the accuracy of the data maintained and will it be processed lawfully, fairly and in a transparent manner in relation to the data subject? The COVID-19 pandemic presented data privacy challenges to companies and institutions, as they have been forced to balance two potentially opposing priorities—protecting public health and personal privacy.[118]

In January 2021, over 281,000 data breach notifications had already been reported across the 27 EU Member States plus the United Kingdom, Norway, Iceland and Liechtenstein since the General Data Protection Regulation came into force on 25 May 2018.[119]

Seeing that the COVID-19 pandemic further sped up digitalization, the concerns are even more prevalent today. While many people enjoyed the benefits of the digital expansion brought on by the current pandemic—such as advances in online human interaction, e-commerce, online education and remote working—many others witnessed exacerbated digital inequalities. With access to the Internet being unequal within and between countries, only about half of the world's population are using the Internet, with less than one in five people in the least developed countries being online;[120] people do not have equal access to technology; therefore they do not have the opportunity to leverage these technologies.

Another concern raised was about the wave of technological advancement that is set to reduce the number of, or even replace, workers currently required for a myriad of tasks. Businesses struggled to limit COVID-19 infections among their workforce while keeping operational costs low. As a potential solution, many turned to new technologies. The move towards such investment, in turn, accelerated the substitution of human tasks with emerging technologies (e.g. AI). This poses a threat to millions of workers unless proactive investments are made in upskilling and reskilling the workforce to accommodate the digital transition.[121]

In the context of the present report, we will focus on four key disruptive technologies of the future, detailing their risks and considering their benefits.[122] These include AI, blockchain, cybersecurity and biotechnology. They were chosen based on their disruptive potential as well as their potential to offer comprehensive and effective solutions to the world's most pressing environmental, economic and social challenges, thereby supporting the realization of the 17 SDGs.

1.3.3.1 Artificial intelligence

AI refers to the "ability of a computer or a computer-enabled robotic system to process information and produce outcomes in a manner similar to the thought process of human learning, decision-making and solving problems."[123] By extension, the objective of AI systems is to develop means of tackling complex problems in ways similar to human logic and reasoning.[124]

Figure 1.7: Potential impact of AI in the United Arab Emirates and Saudi Arabia

Source: PwC, 2018.

While AI offers a wide array of opportunities and has the potential to greatly support sustainable development,[125] increasing reliance on AI systems can lead to significant inadvertent consequences for individuals, organizations and societies. For instance, the malicious use of this cutting-edge technology may jeopardize digital security by training machines to hack or socially engineer victims (such as a phishing attack).[126] AI can also have a significant impact on privacy and data protection. It can be employed in face recognition technology, for Internet surveillance or the profiling of persons, for example.[127] The successful use of AI applications relies on access to large amounts of data, which could challenge the rights of data subjects in terms of how their data is used.

Through privacy-eroding surveillance, profiling and repression, as well as automated and targeted disinformation campaigns, AI could endanger political security and stability, posing a threat to democracy.[128] As observed in recent elections, AI-powered technologies can be misused to manipulate citizens through social media platforms. For instance, during the 2016 United States election, Cambridge Analytica launched a large-scale advertising effort that targeted persuadable voters based on their psychological profiles. To impact people's emotions and choice, this very sophisticated micro-targeting operation used big data and machine learning.[129]

Apart from malicious intent, there can also be unintentional discrimination. As AI is created by humans, "systematic bias may arise as a result of the data used to train systems, or as a result of values held by system developers and users. AI can reinforce discrimination, by fostering racial profiling, behavioural prediction, and even determining a person's sexual orientation. It most frequently occurs when machine learning applications are trained on data that only reflects certain demographic groups, or which reflects societal biases" such as gender bias.[130]

Box 1.7: AI affects gender gaps[1]

Many organizations make decisions based on AI systems employing algorithmic learning from extremely large amounts of data and detecting patterns to make predictions. However, algorithms may be misinformed, reinforcing human biases, such as those related to gender.

One of the leading drivers of gender bias stems from the teams who develop and shape AI systems and its algorithms, which are primarily composed of men. Only 22 percent of AI professionals worldwide are women, according to the World Economic Forum (WEF).[2] Moreover, the data that is fed into the algorithms reflect the gender bias of our societies, and therefore reproduce it and reinforce harmful gender stereotypes.

This gender bias was demonstrated when Amazon set up an AI-powered recruiting tool that unreasonably advantaged male candidates. The algorithm appeared to be trained on a 10-year database of resumés, mostly composed of male applicants (as they are the dominant gender in the technology industry), therefore favouring men over women when vetting applicants.[3]

Problems also arise when applying AI to fields that are already susceptible to bias. The health care sector has historically been biased against women, people of colour and other underrepresented groups that generally tended to be limited in numbers in clinical trials. If algorithms used in the health sector mostly rely on health data from male bodies or exclude representative samples of women (such as women using birth control pills or pregnant women), the resulting medical advice may not be adapted to women, which can put their lives at risk.[4]

Various gender biases that can be reflected in AI can, in turn, have a larger negative impact on business and the economy. To ensure that algorithms are fair, it is of utmost importance to develop the adequate technical, regulatory and privacy environment to collect impartial data sets that are required to train these algorithms.

Notes: 1. See ITU, 2020a; Fatemi, 2020; and Kaushal and others, 2020; **2.** WEF, 2018a; **3.** Dastin, 2018; **4.** Niethammer, 2020.
4. Niethammer, 2020.

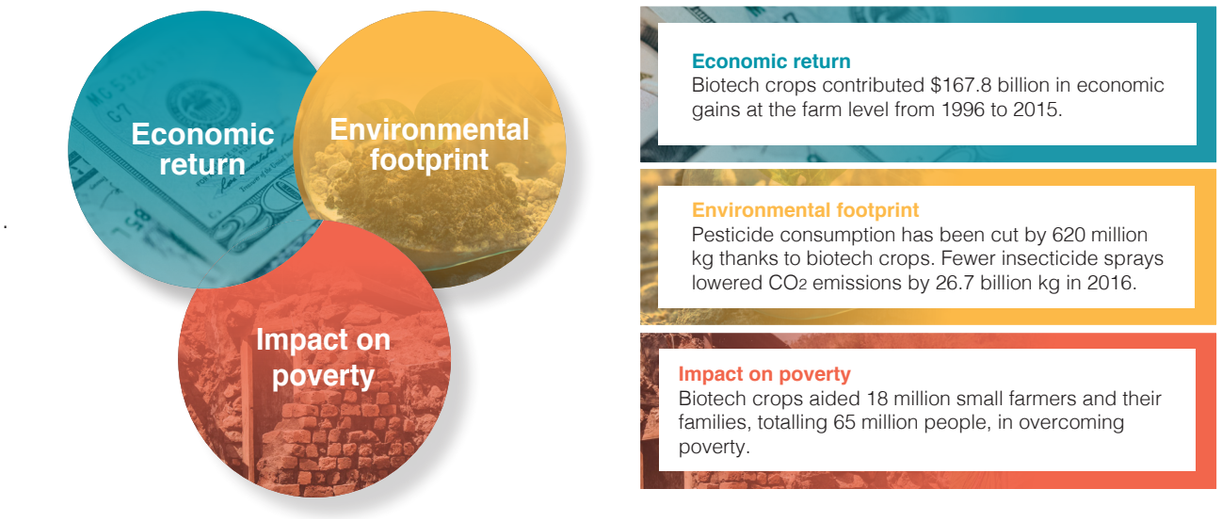
AI could also impact the financial performance of companies and could, therefore impact the economy at large. If trading algorithms are unable to correctly adapt to new circumstances, they could lead to sudden financial losses[131] (e.g. a flash crash, when there is a rapid decline in prices caused by automated trading). There is also a major concern that the use of AI-driven workplace automation has the potential to eliminate large numbers of jobs in some sectors, such as data entry operations managers, etc., while also creating a significant number of jobs in other fields and sectors, such as Internet of Things (IoT) specialists, digital transformation specialists, data analysts and scientists, etc.[132] AI experts and futurists even speculate that AI is already smarter than humans in some areas,[133] will be "vastly smarter than humans" by 2025 and that humans face the threat of being controlled by AI.[134]

1.3.3.2 Biotechnology

Biotechnology involves the manipulation of biological systems (living cells or cell components) for the efficient manufacturing of products. The field of biotechnology is the result of the combined application of physics, chemistry, mathematics and engineering at the molecular level for the study of living cells.[135]

Biotechnology presents potential benefits for world populations in terms of food security and nutrition, and presents widespread applications in human medicine and health care. In cases where industrial biotechnology is based on renewable resources, large energy savings and CO_2 emissions reductions can be expected.[136]

Figure 1.8: Benefits of biotechnology for food security



Source: Varshney, 2017.

On the other hand, biotechnology can be very disruptive and can generate substantial risks. The use of biotechnology in agriculture raises various concerns, one of which is the impact on ecosystem variation in the natural environment and biodiversity loss. Other concerns include the use of genetic data for non-medical purposes—for example, the proliferation of DNA test kits to uncover a person's health profile and ancestry. It has gradually become clear that the main source of revenue for some of the companies that offer this service comes from selling the data on to third parties. Another possible risk is the intentional or unintentional release of very dangerous microorganisms. The advancements in biotechnology and biochemistry over the decades have simplified the development and production of biological weapons whereby bioterrorists can modify microbes using currently available molecular technologies to make them more contagious, virulent or resistant to treatment in order to cause maximum casualties.[137]

Lastly, rapid biotechnological developments raise questions about animal welfare, especially when applied to animals that are genetically modified, or treated with biotechnological products. There are also concerns about new applications or the large-scale use of agricultural food and feed products for non-food industrial purposes when food security remains an issue in many countries.[138]

1.3.3.3 Blockchain

Blockchain is a "distributed and tamper-proof database technology that can be used to store any type of data, including financial transactions, and has the ability to create trust in an untrustworthy environment."[139] By providing a high level of security, blockchain can be an important component in digital infrastructure, where trusted digital applications can be used.

Blockchain promises to drive efficiency in business processes, as it supports automation and fraud prevention, while also increasing the transparency, traceability, speed and efficiency of transactions.[140] Blockchain is widely used for financial services, as it notably brings us closer to real-time transactions between financial institutions and decreases costs by removing intermediaries.[141] While most of its uses are in financial services, blockchain is equally promising in the health care sector. Blockchain has the potential to track and address the causes of fluctuations in spending on health as a share of GDP, as it has registered a 4.9 percent growth between 2000 and 2010 that has decreased to 3.4 percent between 2010 and 2017.[142] Patients, physicians and health care professionals have the possibility to exchange up-to-date information swiftly and safely thanks to the technology's decentralized structure that could streamline and accelerate diagnosis and vital medical care.[143] In 2016, Estonia turned to blockchain to secure the health records of its 1.3 million residents.[144] Most recently, the Ministry of Community Development in the United Arab Emirates has harnessed blockchain for digital authentication of official certificates during the COVID-19 pandemic to facilitate government services and efficiently complete requests.[145]

Despite its enormous potential in solving problems, blockchain also presents new challenges for firms and markets. The implementation of a blockchain solution may often create challenges related to interoperability and integration with other systems. It also poses risks to data management, including confidentiality and compliance with applicable regulations, such as the European Union's General Data Protection Regulation. Unauthorized parties using a private blockchain can threaten the integrity and privacy of the blockchain, and in turn endanger the transactions being recorded.[146] Furthermore, blockchain-based corporate processes may be prone to "technological and operational failures, as well as cyberattacks."[147] According to Atlas VPN, "blockchain hackers stole nearly $3.78 billion in 122 attacks throughout 2020."[148]

Another danger is the current ambiguity around regulations for blockchain applications, which may put business processes and models in doubt. It is critical for businesses to have a solid risk management strategy to respond to the myriad hazards that this revolutionary technology presents.[149]

Blockchain hackers stole nearly $3.78 billion in 122 attacks throughout 2020.

1.3.3.4 Cybersecurity

Cybersecurity refers to the technologies, processes and controls that aim to safeguard systems, networks and programmes against digital attacks, damage or unauthorized access.[150] Global venture funding in cybersecurity has grown significantly in recent years, reaching $7.8 billion in 2020 (the record year, thus far) and is expected to further increase in 2021.[151] Also, cybersecurity has been identified as a top priority for new spending by more than 61 percent of the 2,000+ Chief Information Officers (CIO) surveyed by the Gartner 2021 CIO Agenda Survey.[152] By adopting cybersecurity solutions, governments and businesses are able to: i) combat any unauthorized access to their data, including those which are personal; ii) improve business continuity management in case of a cyberattack and foster productivity; and iii) recover faster in the event of a breach. Furthermore, as the advent of the COVID-19 pandemic has incentivized and accelerated the digitalization of government and business processes, private and public investments in cybersecurity are expected to grow exponentially in the coming years.

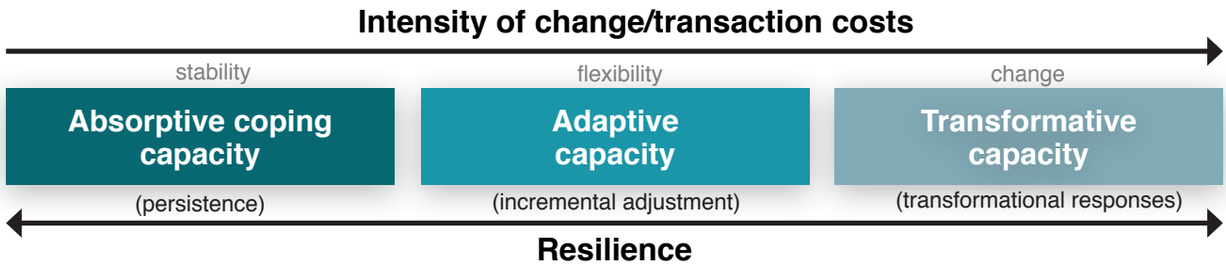
Cybersecurity failure is considered among the most important global risks for humanity in the short and medium terms and the top risk among technological risks.[153] Cyberattacks commonly involve attempts to access, alter or damage sensitive information which can result in extortion of money, infringement of intellectual property rights or a disruption of service provisions. Cyberattacks target information such as trade secrets, intellectual property (including source code), customer information or employee records. When successful, they can cause significant downtime or unplanned outages that prevent the organization from meeting its data processing requirements. Cyberattacks on key infrastructure and information resources result in losses of income and lead to significant costs in repair of equipment and other IT assets, but also more intangible assets such as brand and reputation. Internal costs associated with cyberattack detection, investigation, containment and recovery are also incurred and can hence weigh on profitability and economic performance of businesses.[154]

Cyberattacks affect nearly all stakeholders operating in the digital world, ranging from businesses to governments to end consumers. As our world is becoming more and more intertwined with network-connected devices and services, risks to cybersecurity are undoubtedly increasing. Cybersecurity infrastructure and measures require improvement. The advancement in technology produces increasingly sophisticated cybercrimes, which can lead to economic disruption, financial loss, geopolitical tensions or social instability.[155] Businesses that suffer from cybersecurity failures can face highly damaging regulatory scrutiny, legal consequences and reputational harm. For governments, leaks of sensitive state information may undermine national security.[156] For citizens, cybersecurity failures can lead to the violation of their individual right to data privacy—an increasingly critical and fundamental human right. The *Cost of a Data Breach Report* revealed that the average total cost of a data breach amounted to $3.86 million in 2020 which requires an average of 280 days to identify and contain the breach. Also, the report highlights the fact that the health care sector is the most affected by data breaches.[157] Another strand of literature highlights the vulnerability of SMEs to such types of cyber risks, whereby 60 percent of small companies that suffer a cyberattack can be put out of business within six months.[158]

1.4 TRANSFORMATIVE CAPACITY

While the risks that countries are facing are significant, governments have several means at their disposal to address them. Research shows that countries can build different types of capacities in order boost their resilience—i.e. "the ability of households, communities and nations to absorb and recover from shock, whilst positively adapting and transforming their structures and means for living in the face of long-term stresses, change and uncertainty."[159] The three capacities that underpin the resilience framework are absorptive, adaptive and transformative. The concept of transformative capacity – which is in focus for this report and will be addressed from a knowledge-based and skills perspective – captures the mechanisms that enable countries to effectively function in the face of shock and still meet a series of well-being outcomes.

Figure 1.9: The 3D resilience framework



Source: Béné and others, 2012.

Transformative capacity is defined as the ability of a country to adjust, modify or completely change its characteristics (e.g. ecological, economic, social structures, etc.). It may also refer to the ability of people to have choices in responding to change and to the flexibility of organizations and institutions to adjust rules, boundaries, partners and membership.[160] In doing so, the country can continue to operate with few or no changes in its core functions in the event of a shock.[161] The notion of transformative capacity also refers to the ability to adapt and move towards a more sustainable future.[162] Understanding countries' transformative capacities could lead to their ability to adapt to impactful disruptions and to reinforce sustainable development, therefore contributing to building a better and more inclusive future. In that sense, transformative capacities should be seen as key factors against which a country's vulnerability, inequalities and risks are assessed.[163]

Transformative capacities – and a transformed country – can translate, for instance, into further investment in people (especially youth) and better use of natural resources, with the goal of shifting the country's future towards resilience and progress. A transformed country would in turn be better equipped to deal more effectively with fragile environment, situation and risks/crises (e.g. political conflict, water scarcity, health issues, etc.). Such eventualities have already disrupted the livelihoods of citizens – especially those who are most vulnerable – and threatens to disrupt others if no urgent action is taken to resolve them.[164]

Transformative capacity is built on two main characteristics – innovative capacity (i.e. the ability of the system to create an enabling environment fostering innovation and experimentation) and collaborative capacity (i.e. the ability to organize and act collectively). These two types of capacities were quickly recognized as key components that can: i) help respond to the COVID-19 pandemic;[165] and ii) drive the sustainable recovery of countries, moving forward.[166,167] Unsurprisingly, in a world that is globalized and where challenges (climate change, health, inclusive economic development) are heavily interconnected, solutions aimed at adjusting or transforming countries' socioeconomic systems in line with the ecosystem need multiple actors to develop.[168] Solutions need to be holistic; they can follow both a bottom-up and a top-down approach. The ability to work together across governments, the private sector and among citizens is crucial to helping countries respond to risks through transformation. Likewise, innovation can help absorb shocks, allowing countries to operate with limited negative impacts. This was amply demonstrated during the COVID-19 crisis,[169] when digital innovations played a key role in: i) alleviating the impact of the pandemic; and ii) adapting and tailoring the services of governments and the private sector to the needs of citizens. For instance, the European construction sector (one of the least digitalized sectors) adapted to the new normal by implementing digital solutions such as 'Building Information Modelling' and 'Digital Twins'.[170] The adoption of these digital tools not only minimized the impact of the pandemic, but will also help to transform the sector into a more sustainable model, from an environmental and economic point of view.[171] Innovation, as a means of modifying economic systems, in addition to social and environmental systems, is a key component of transformative capacities.

Both collaboration and innovation are reflected in the SDGs. SDG 17 is dedicated to strengthening partnerships for sustainable development, highlighting the need to work in multi-stakeholder partnerships and through voluntary commitments, across countries and regions, and across institutions and sectors. Likewise, innovation for sustainable development is well-embedded in most of the SDGs as a means of supporting inclusive and sustainable development. Collaborative and innovative capacities are even more crucial when considering the level of interconnectedness and complexity of the risks aforementioned. In other words, the capacity to collaborate and innovate are *sine qua non* for countries in order to be prepared to address future health, environmental and technological risks.

Innovation could be defined as a means of creating knowledge and providing answers to the urgent global challenges faced by our societies, such as demographic changes and environmental risks, resource scarcity, or other global risks and is often perceived as a driver of sustainable and resilient economic and social growth.[172,173] Innovation is often associated with GDP growth:[174] the advancement in innovation in the United States is said to contribute to half of its GDP growth;[175] in the Middle East and North Africa (MENA) region, the GDP could increase by 4 percent if R&D intensity would rise by 10 percent.[176] Innovations also have a wider impact on the environment and our societies. For instance, evidence from BRICS economies (Brazil, Russia, India, China, and South Africa) shows that investments in green technologies are found to improve countries' sustainable development.[177]

In the MENA region, GDP could increase by 4% if R&D intensity would rise by 10%.

Although this may be true, the United Nations Conference on Trade and Development (UNCTAD) stresses that worldwide disparities strongly impact a country's capacity to innovate. In upper-middle- and high-income countries, the average share of the population living in extreme poverty is only 2 percent, in lower-middle-income countries it stands at 14 percent and in low-income countries it is 45 percent. Similar disparities are seen in child mortality rates, the prevalence of underweight children, and in education, particularly at higher academic levels. In 2018, only 41 percent of the population of low-income countries in the relevant age group were enrolled in secondary education – compared to 90 percent enrolment in upper-middle- and high-income countries. Since innovation is fundamental to addressing risks and disruptions of all sorts, and since most issues are interconnected on a global scale, there is a clear need for the international community to support developing countries in building their innovative capacities.[178]

Recent research emphasizes the importance of collaborative capacity as a key driver of transformation. Collaborative engagement, characterized by "reciprocity, trust and mutual respect between various stakeholders," is described as the best way to build collective resilience to disasters.[179] Collaboration enables individual countries to have access to larger resources and thus facilitates the adaptation of societies.[180] For example, the Institut Pasteur in Dakar, Senegal has been working closely with the British biotechnology firm Mologic to develop a new form of rapid test kit for the COVID-19 virus, to be made and distributed in Africa from their custom-built DiaTropix facility.[181] Another example of collaboration to address risks (in this case technological) is the data security cooperation initiative signed between China and the League of Arab States[182] aimed at increasing efforts towards a more cohesive structure of global digital governance. On another level, the SDGs, that define sustainable goals to which countries should move towards, are built on the principle of 'leaving no one behind,' emphasizing the need for a collaborative approach for sustainable evolution. More recently, research on the COVID-19 pandemic suggests that collaboration is a significant determinant in overcoming crises and in developing a better and more resilient future.[183] Also, the decade of action requires countries and institutions to reinvent themselves and join forces to achieve the ambitious 2030 Agenda.[184]

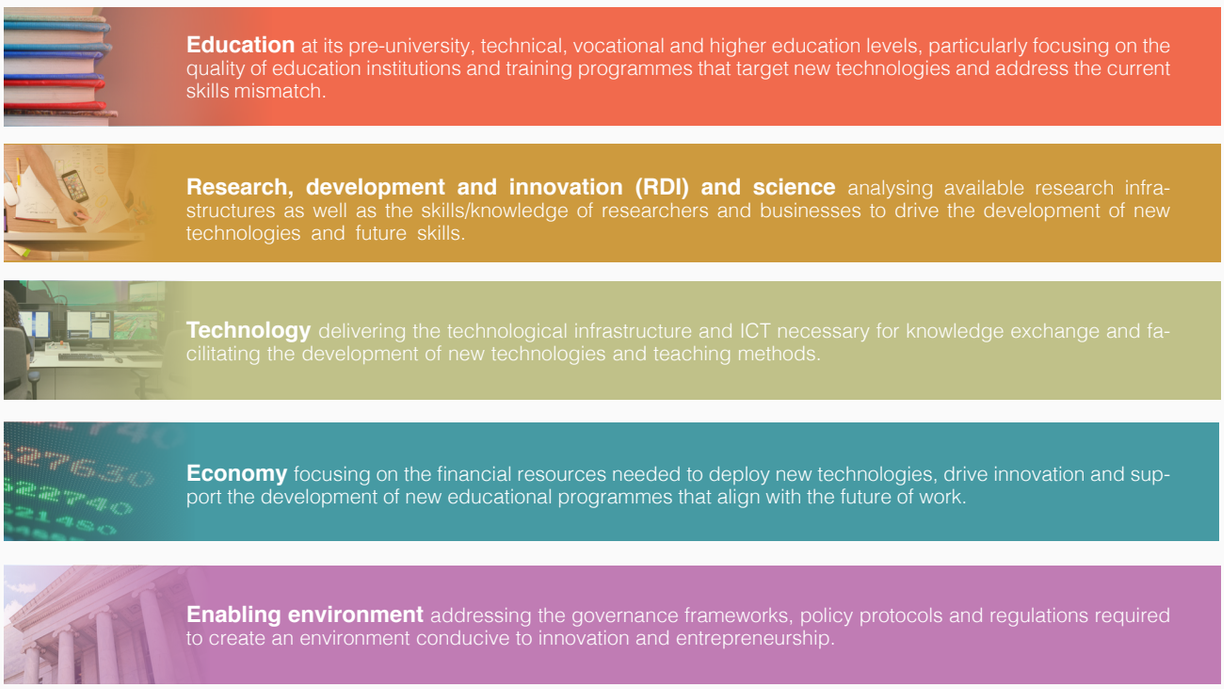
As such, this report explores the role of collaborative and innovative capacities from a knowledge and skills perspective in dealing with health, environmental and technological risks that are expected to pose a threat to society's progress.

1.5 KNOWLEDGE DIMENSIONS AND FUTURE SKILLS

The 2018 and 2019 Future of Knowledge Reports identified five key dimensions that require investment as a precondition for knowledge-based development: education, RDI and science, technology, economy and the enabling environment.

Referred to as 'knowledge dimensions,' these are built on the framework of the Global Knowledge Index[185] and the 2030 Agenda for Sustainable Development and are identified in this report as the most impactful solutions that can be leveraged to respond to global risks. A higher level of awareness of these dimensions translates into a higher degree of preparedness of countries to leverage knowledge dimensions to tackle future risks.

Box 1.8: Knowledge dimensions



Source: UNDP and MBRF, 2019a.

Investment into future skills will be another key determinant for a country's ability to phase in upcoming transformative changes. Recent research states that one third of all jobs could be at risk of automation in the next decade[186] and that 45 percent of jobs in six Arab countries[187] with very high and high human development are technically automatable today, which could be associated with 20.8 million full-time employees and $366.6 billion in wages.[188] While the WEF estimates that, by 2025, 85 million jobs may be displaced by a shift in the division of labour between humans, machines and algorithms, 97 million new roles may emerge that are more adapted to this new division of labour.[189] In this context, emerging roles include AI and machine learning specialists, software and application developers and analysts, big data specialists, information security analysts, blockchain specialists and digital transformation specialists. The COVID-19 pandemic accelerated this shift, as it pushed companies to rely further on digital processes and technologies.[190]

Beyond the need for digital skills, some sectors suffer from a shortage of technical skills. For instance, the health care sector faces a notable technical skills shortage, which the pandemic rendered even more severe. WHO estimates a projected shortfall of 18 million health workers by 2030, mostly in low- and lower-middle-income countries.[191] They predict that countries at all levels of socioeconomic development will face, to varying degrees, difficulties in the education, employment, deployment, retention and performance of their workforce.

It is important to note that future skills do not solely include digital or technical skills. The emerging roles require skills such as creativity, emotional intelligence, problem-solving, data-driven decision-making and design/critical thinking skills. Soft or transversal skills are becoming increasingly important, as individuals need agility to progress in an ever-changing digital world.

Table 1.1: Evolution of the most important future skills

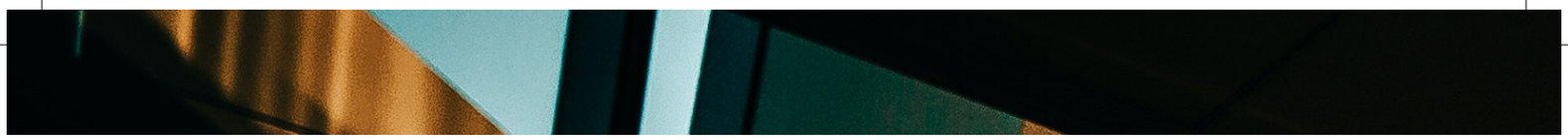
2020	2025
Complex problem-solving	Analytical thinking and innovation
Creative thinking	Active learning and learning strategies
Creativity	Complex problem-solving
People management	Critical thinking and analysis
Coordinating with others	Creativity, originality and initiative
Emotional intelligence	Leadership and social influence
Judgement and decision-making	Technology use, monitoring and control
Service orientation	Technology design and programming
Negotiation	Resilience, stress tolerance and flexibility
Cognitive flexibility	Reasoning, problem solving and ideation

Source: Gray, 2016; WEF, 2020b.

Frankiewicz and Chamorro-Permuzic point out the importance of hiring workers who demonstrate learnability, allowing organizations to adapt to future needs and risks.[192] Leadership is also a quality that should be sought out by organizations. Leadership is said to be crucial in supporting the transformation of an organization, successfully guiding talent and fostering teamwork and collaboration. Notwithstanding, a slight shift can be observed in the top 10 skills needed in the future, with skills relating to people (people management, coordinating with others and emotional intelligence) moving down the list to leave room for skills related to technology use, monitoring and controls, as well as technology design and programming. As much as the impact and weight of technologies is reflected in future skills, transversal skills[193] should not be overlooked.

It is important to highlight that the skills shortage does not affect all workers equally. This is particularly the case for digital skills. During the COVID-19 pandemic, existing digital inequalities have been reinforced. Workers with low digital literacy were particularly affected by the negative consequences of the pandemic. While the pandemic has significantly accelerated societal digital transformation, it has also widened the gap between people who have access to digital tools and digital skill learning programmes, and those who do not.

Ensuring that citizens' skills remain relevant is a key challenge for governments. Several governments developed or supported upskilling and reskilling initiatives through technical assistance or financial resources. This is the case for countries such as Luxembourg (see Box 1.9), France and Denmark, albeit they take different approaches to supporting their workers in upskilling. During the COVID-19 crisis, public support for reskilling/upskilling focused on the following: i) more flexibility in funding rules, training periods, and the scheduling of off-the-job and on-the-job training. This allowed for a focus on the off-the-job training during lockdown periods, assessments, and apprenticeship training completion; ii) establishing free online learning platforms and radio and television channels; iii) offering financial assistance to both businesses and apprentices, such as salary subsidies and digital equipment.[194] However, such support is often too limited with only 21 percent of enterprises able to make use of public funds to support their employees' reskilling and upskilling efforts.[195]



Box 1.9: The 2018–2019 ‘Luxembourg Digital Skills Bridge’ pilot project

The Luxembourg Digital Skills Bridge project was carried out with the aim of anticipating the impacts of technological advances on jobs and to test (as a “proof of concept”) the usefulness of supporting companies and their employees in the transformation of their work, jobs and skills.

The objectives of the pilot project are to:

1. Raise awareness and support companies which activities have or will be significantly transformed by digital disruption;

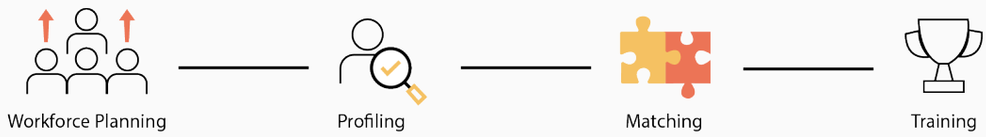
2. Coach and upskill the employees that are the most impacted – and advise them on new opportunities (internal or external) according to their preferences and potential;

3. Achieve a 65 percent internal mobility rate for pilot project participants;

4. Demonstrate the value of a proactive and preventive upskilling approach for companies, employees and the society;

5. Develop an ecosystem of relevant assessment and upskilling solutions.

The participating companies and employees undergo four key steps:



1. Workforce Planning

Following a quantitative and qualitative analysis (supported by innovative tools) of the impact of new technologies on the company, of the past mobility of the company’s workforce and a projection of the future workforce needs, the company has established a skills development plan identifying occupations at risk and skills development needs for future activities. These skills development plans have then been certified by the Economic Committee (Comité de conjoncture).

2. Profiling

For the employees in the occupations identified as high-risk and participating in the program, the SkillsBridge personal coaches conducted an analysis of their competency profiles and preferences, supported by profiling tools. For this purpose, 25 individual advisers were trained and certified.

3. Matching

The next step (carried out by the personal coaches and supported by AI-based tools) allowed to find internal or external job matches for the highly impacted employees (with a potential job loss), corresponding to their profile and preferences, and indicating the skills that remain to be developed for the job transition (skills gap). This led to the elaboration of an individual skills development plan for each participating employee. For the employees who stayed in the same position (but where the position was likely to change significantly), the future skills required for this position were taken as the basis for the individual skills development plan.

4. Training

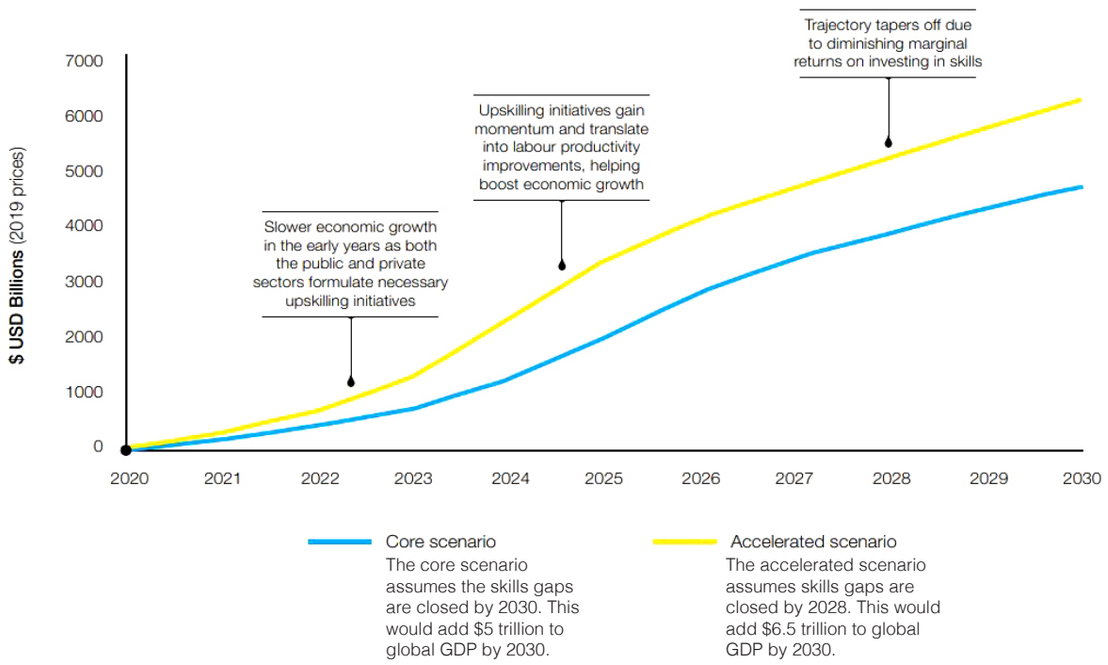
In this final and important step, each participating employee attended training (soft, digital and job-specific) in accordance with their individual skills development plan, and received advice on self-branding.

To cover this entire journey, the Ministry co-financed for each participating company: maximum 12 days of technical assistance to the company for workforce analysis and planning, maximum 1 day of personal coaching per employee, maximum 35 percent of the training expenses and 90 percent of the salary expenses during the training period (“chômage partiel”).

Source: The Government of the Grand Duchy of Luxembourg, 2018.

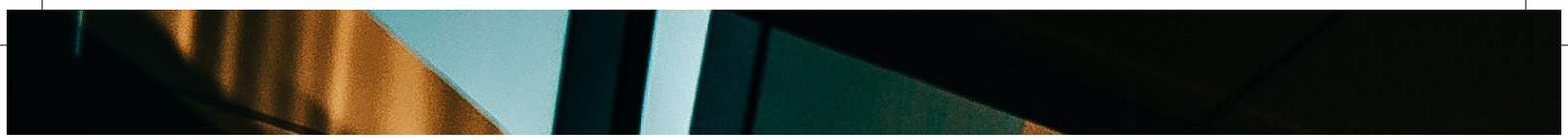
It is crucial to note that upskilling and reskilling initiatives require a multi-stakeholder approach in order to be effective. Governments, businesses, education providers and social partners need to work together to address labour and skills' gaps. Only a few initiatives adopt such an approach, leaving a lot of room for improvment. It is through collaboration that the sustainable development of countries can be achieved.

Figure 1.10: Additional GDP potential due to upskilling, 2020-2030 (2019 prices, billion US$)



Note: Based on PwC data analysis, December 2020.
Source: WEF, 2021b.

Thus, future skills development and knowledge are very important dimensions to facilitate efforts to: i) explore solutions to health, environmental and technological risks, and ii) exploit transformative capacities to address them.



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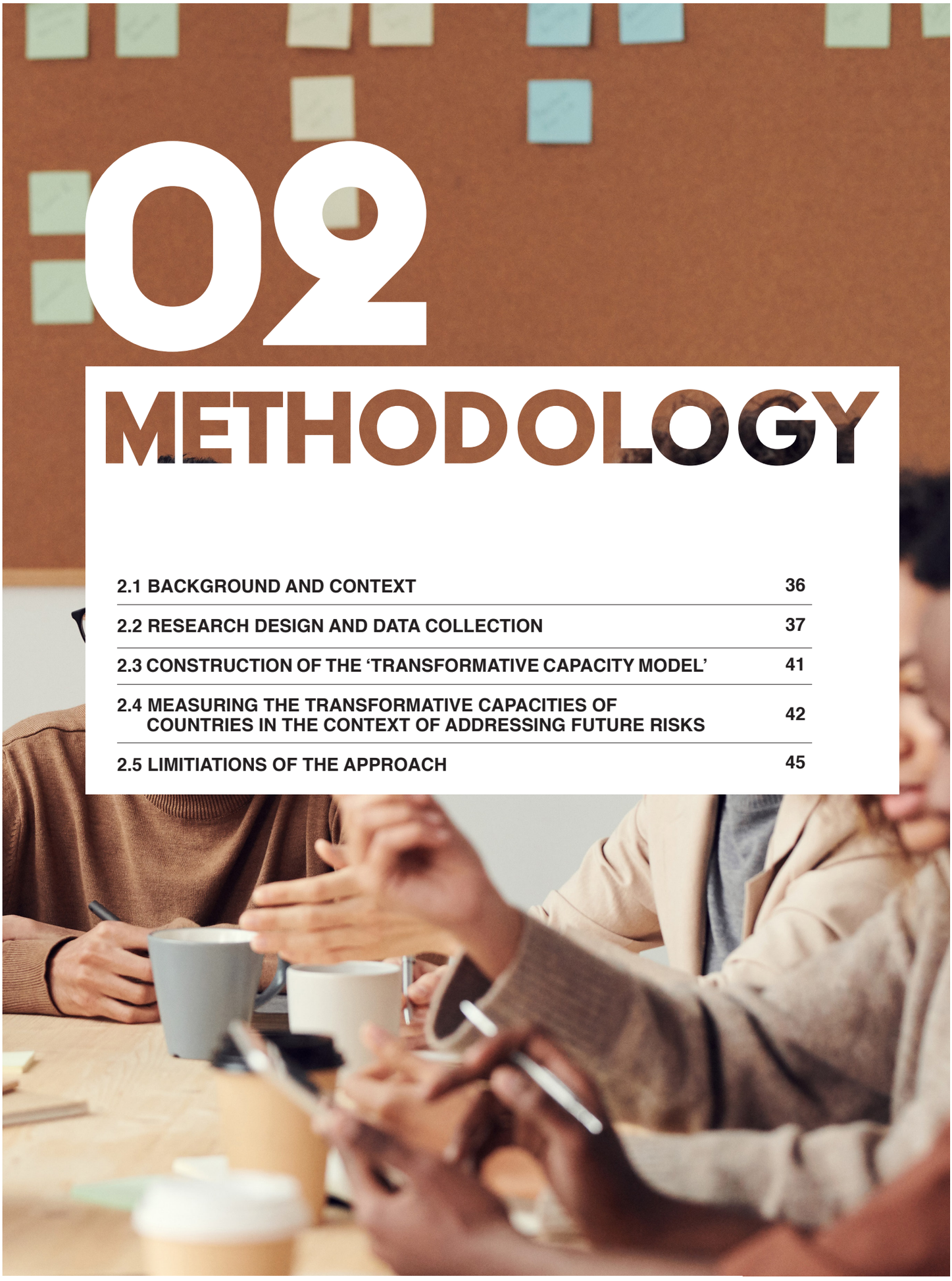
162. Wolfram, 2016.
163. Castillo, Jeans and Thomas, 2017.
164. UNDP, 2011.
165. See WHO, 2021d.
166. See ADB, 2021.
167. UNCTAD, 2020b.
168. This is notably highlighted in the UN SDG Agenda, as detailed in the below paragraph.
169. UNDP, n.d.-c.
170. EC, 2021a.
171. Ibid.
172. OECD, 2017c.
173. Linné and Wibeck, 2020.
174. The OECD notes that, for instance, "investments in software have also contributed significantly to business performance and economic growth, accounting for as much as one-third of the contribution of ICT (information and communications technology) capital to GDP growth since 1995 in Denmark, France, the Netherlands, Sweden and the United States."
175. See US Chamber of Commerce Foundation, 2015.
176. Omar, 2019.
177. Danish and Ulucak, 2020.
178. UNCTAD, 2021.
179. Esteban, 2020.
180. Cinner and others, 2018.
181. See Mologic, 2020.
182. See Kobierski, 2021.
183. Bhattacharya and Stern, 2020.
184. IISD, 2018.
185. See UNDP and MBRF, 2019a.
186. WEF, 2020a.
187. Bahrain, Egypt, Kuwait, Oman, Saudi Arabia and the United Arab Emirates.
188. World Government Summit and McKinsey & Company, 2018.
189. WEF, 2020b.
190. Ibid.
191. WHO, n.d.-c.
192. Frankiewicz and Chamorro-Premuzic, 2020.
193. Including, for example, the ability to communicate and collaborate effectively across disciplines, as well as the individual's capacity for enhanced and accelerated learning.
194. ILO, 2021b.
195. WEF, 2020b.



02 METHODOLOGY

02 METHODOLOGY

2.1 BACKGROUND AND CONTEXT

2.1.1 Knowledge and skills: Building a country's transformative capacities and preparedness for future risks

Whether a country is prepared to respond to future risks is highly dependent on its knowledge landscape and its ability to anticipate and modernize its population's skillset. The better equipped the labour force is in terms of skills, and the more sophisticated its knowledge dimensions (education; research, development and innovation (RDI) and science; technology; economy; and enabling environment), the more prepared a country will be to address future health, environmental and technological risks. Collaborative and innovative capacities are perceived as key elements that can shape and influence the abilities of countries to leverage their knowledge dimensions and workforce skillsets. These (transformative) capacities therefore play a key role in helping countries to adjust, modify and even completely change their characteristics (e.g. environmental, economic, social structures, etc.) while responding to future risks without disrupting their operations.

However, while data concerning knowledge dimensions[1]—and to a lesser extent, skills[2]—is available at the global level, limited data is available when it comes to understanding and measuring transformative capacities at the country level. This is partly explained by the difficulties of translating intangible elements into measurable data.

To support the improvement of countries' preparedness to respond to future risks, this report developed metrics to capture their collaborative and innovative capacities, from both knowledge- and skills-based perspectives, for each of the key future risks previously defined — i.e. health, environmental and technological. These metrics are based on online and social media data analytics, allowing for the measurement and comparison of individual countries' transformative capacities by gauging their degree of awareness concerning the importance of leveraging collaboration and innovation to respond to each of the risks identified, over time. In doing so, this report provides robust and up-to-date estimates of the current transformative capacities of countries to respond to future risks.

2.1.2 Alternative metrics based on big data

To better understand a country's transformative capacities and its level of preparedness to address future risks, this report leveraged alternative metrics based on big data and machine learning. This provides: i) quantitative data comparable across 40 selected countries over a specified period of time; ii) real-time data on the awareness of a country's transformative capacities; and iii) qualitative insights in terms of the forward-looking initiatives countries may implement to respond to future risks. This is made possible by the ability of machine learning to process massive amounts of data. The use of big data is coupled with web scraping techniques to filter relevant information from the vast volume of data collected.

This edition of the Future of Knowledge Foresight Report series therefore contributes to the existing literature by offering new insights relating to the preparedness of countries to address future risks. Both traditional types of statistical/qualitative metrics are compiled, as well as alternative metrics including data points from a wide range of stakeholders—companies, industry associations, media outlets, social media users, bloggers and private individuals—to provide new insights and findings. The metrics not only reflect government/industry perspectives, but also a societal perspective.

2.2 RESEARCH DESIGN AND DATA COLLECTION

2.2.1 Using social media to measure transformative capacities

This analysis of online and social media data builds on the experience gained from the previous editions of the Future of Knowledge Foresight Report series. Social media is often used during disasters as a platform to share information relating to crisis management and the coordination of response and recovery activities.[3] During the COVID-19 pandemic, many turned to social media to obtain and circulate medical information, thus further raising awareness about the virus among their virtual social networks.[4] This trend gained traction following the imposition of physical distancing rules in many countries and the consequent shift toward remote working.

Research finds that social media has had a positive impact in the context of raising awareness and sharing knowledge relating to the COVID-19 pandemic.[5,6] This is also in line with literature concerning climate-related disasters, which reveals that increased awareness improves peoples' preparedness for disasters and enables them to adjust to changes.[7] The knowledge dimensions of this process are of prime importance, as more awareness leads to increased empirical (and often theoretical) knowledge, which is a key pillar for developing collaborative and innovative capacities.

2.2.2 Leveraging social listening to collect data

To measure a country's transformative capacities, this report uses a digital intelligence platform (DIP) that gives access to 150 million public sources in over 180 languages. The DIP requires the development of queries, written in specialized language and Boolean operators, and uses advanced analytics with AI capacities to identify and extract the most relevant data. It uses a machine learning algorithm to compute key metrics such as audience mentions and engagement, including the total number of audience interactions with a page/post, i.e. likes, shares, retweets and comments, and sentiment analysis (positive, negative or neutral).

2.2.2.1 Defining the research scope

This report investigates the transformative capacity, and hence the level of preparedness of countries vis-à-vis future risks across 40 selected countries. The country selection is based on the performance of countries in the Global Knowledge Index, using an unsupervised machine learning method called 'clustering', and follows the selection of the 2019 Future of Knowledge report to ensure coherence and consistency between different editions of the series.

Figure 2.1: Countries included in the study

Through the DIP, this report collected and analysed online and social media data from more than 150 million public sources. Table 2.1 presents the proportion of results found by each media type by country.

Table 2.1: Proportion of media by country (in percent)

Country	Media						
	Online news	Newspaper	Magazine	Blogs	Forums	Twitter	Other
Australia	42.72	1.67	0.16	5.88	0.49	48.82	0.26
Bangladesh	42.51	1.99	0	13.54	0.03	41.93	0
Brazil	12.2	3.77	0.56	16.39	0.2	66.07	0.81
Cameroon	14.63	0	0	17.7	0	67.37	0.3
Chile	6.34	3.68	0.18	9.22	0.09	79.67	0.82
Egypt	71.88	0	0.41	14.38	0.16	13.15	0.02
Ethiopia	1.45	0	0	8.42	0	90.13	0
Finland	15.23	6	1.98	7.91	1.51	67.05	0.32
France	15.58	2.21	1.96	14.84	2.21	61.09	2.11
Germany	39.57	6.6	1.69	12.68	2.44	31.73	5.29
Ghana	16.9	4.08	0	15.01	0	64	0.01
Greece	29.96	3.14	1.83	45	0.3	18.7	1.07
India	15.22	4.29	0.2	14.67	0.11	65.01	0.5
Indonesia	17.07	4.65	0.36	11.67	0.2	57.33	8.72
Japan	17.72	0.15	0.06	7.32	3.64	70.91	0.2
Jordan	61.62	3.42	0	7.23	0	27.72	0.01
Kazakhstan	67.39	0	0.08	14.97	5.28	12.15	0.13
Kuwait	18.32	0	0	5.08	0	75.51	1.09
Lebanon	28.92	0.07	0	11.83	0	54.52	4.66
Luxembourg	24.41	14.62	4.56	5.88	0	50.4	0.13
Malaysia	18.99	7.48	0.73	14.95	2.18	53.62	2.05
Mexico	12.07	2.41	0.31	13.77	0	71.31	0.13
Morocco	37.94	4.4	0.93	36.02	1.01	18.78	0.92
Netherlands	19.5	0.45	1.5	9.96	4.18	64.12	0.29
Poland	40.39	4.12	2.58	29.56	1.66	20.83	0.86
Russian Federation	43.48	4.28	0.65	19.07	11.8	11.73	8.99
Rwanda	4.83	0	0	4.28	0	90.89	0
Saudi Arabia	31.23	0.82	0.01	12.4	2.67	52.62	0.25
Senegal	24.4	0.62	0	24.77	0	49.96	0.25
Singapore	31.02	6.23	0.27	8.38	2.97	50.02	1.11
South Africa	19.14	1.28	0.13	11.81	0.48	66.94	0.22
Sweden	11.25	11.46	2.35	16.29	2.87	55.02	0.76
Switzerland	41.71	5.74	1.12	5.09	0.77	44.35	1.22
Tajikistan	34.41	0	0	46.86	0.38	18.35	0
Tanzania (United Republic of)	13	1.9	0	11.35	4.06	69.69	0
Turkey	33.12	2.59	0.14	7.91	0.42	54.67	1.15
United Arab Emirates	51.97	1.93	0.46	11.78	0.1	25.67	8.09
United Kingdom	14.22	12.24	1	8.33	0.52	62.36	1.33
United States	15.47	0.98	0.95	14.15	5.72	60.08	2.65
Viet Nam	59.75	13.31	0.34	15.67	4.19	3.82	2.92

As in previous years, Twitter and online news account for the majority of the results; however, it is interesting to note that the proportion of results from online news was much higher in this edition for most countries. Instagram was discarded, as it generated significant data noise (i.e. a significant share of the results extracted though the DIP was deemed irrelevant).[8]

This report examines the differences between countries' transformative capacities with respect to key global risks over a two-year period. All online, publicly available data extracted was published between 3 June 2019, 00:00:00 GMT+1 and 30 May 2021, 23:59:59 GMT+1. Therefore, this report captures variations before and during the outbreak of the COVID-19 pandemic, as well as the transition from the emergency to the recovery stages of the crisis already witnessed in several countries. While this report acknowledges that the pandemic did not occur—or generate awareness—simultaneously in all countries, it considers the period February–March 2020 as an indicative timeframe during which the pandemic's global impacts began to materialize, coinciding with two important events: the WHO Director-General declaring COVID-19 as a 'public health emergency of international concern' on 30 January 2020,[9] and later as a 'pandemic' on 11 March 2020.[10] Therefore, the emergency and recovery stages of the crisis may be observed in the period following those months.

2.2.2.2 Designing the 'queries'

Queries are requests for information from a database written in specialized language, which in this case involves the use of Boolean operators. The process of generating a query consists of four main steps, as described below.

Figure 2.2: Four steps of designing a query

The lists of keywords and queries were developed for: i) health, environmental and technological risks; ii) knowledge dimensions and future skills; and iii) collaborative and innovative capacities, as presented in Chapter 1.

A. Defining the keywords

Defining keywords is a crucial step that allows for a more precise definition and scoping of the respective meanings of 'risk', 'dimension' and 'capacity'. To develop the list of keywords, a three-step approach was followed, beginning with a review of the existing literature including, *inter alia*, strategic documents and reports from international organizations, articles and social media posts. On this basis, a workshop was convened with subject matter experts in fields such as environment and health, to discuss a preliminary list of keywords. Their input was then tested and validated by linguists, who helped ensure that the keywords would generate relevant results, hence avoiding potential noise.

The definition of 'health risks' is based on SDG 3, 'Good Health and Well-Being',[11] and more specifically the targets related to: i) communicable diseases; ii) non-communicable diseases and mental health; and iii) health risk factors and outcomes. These sub-themes are also identified by the WHO in its 'global health issues to track in 2021'.[12] Each of these areas became the basis for a risk sub-theme with its own set of keywords, supplemented by additional keywords for cross-cutting dimensions that capture broader developments relating to health risks.

The list of keywords relating to environmental risks focuses on three sub-themes reflected in the UNDP *Strategic Plan 2018–2021*[13] and UNEP *Medium-Term Strategy 2022–2025*[14] — climate change; biodiversity loss and natural resources; and pollution—in addition to a horizontal environmental sub-theme that captures broader trends that are not included in these sub-themes. These are the main global (and interconnected) crises or risks affecting our relationship with the natural world and jeopardizing global economic and social well-being, as reflected in the 2030 Agenda. Therefore, keywords were developed for each of these sub-themes.

The list of keywords for technological risks closely follows that developed for the 2019 edition of the Future of Knowledge report to ensure a certain degree of consistency and coherence. The technological risk query was therefore divided into four sub-themes, namely AI, cybersecurity, biotechnology and blockchain, which all include their own lists of keywords.

Just as for knowledge dimensions and future skills, a set of keywords was developed for collaborative and innovative capacities. Keywords and terms under collaborative capacity include 'joint action', 'partnership' and 'cooperation', for example, whereas those for innovative capacity include 'inventions', 'cutting-edge', 'pioneer', 'forward-thinking', 'ground-breaking' and 'state-of-the-art'.

B. Defining the queries

The search queries were developed using special Boolean operators that allow for a higher degree of relatedness between groups of keywords, thereby increasing the likelihood that the result is relevant to the target dimensions. In addition to the Boolean operators, the keywords were enhanced by adding synonyms or related words to ensure the findings were both comprehensive and relevant, i.e. that the results reflected the definition and understanding of the risks, dimensions and capacities.

The last portion of the query was the geolocation operator, which limited the results to publications originating in the sampled countries. The DIP determined the location of a given publication based on the metadata available for the result, according to the following hierarchy:

1. the geolocation of the article/post, if enabled by the user;
2. the location found within the contact/profile section (e.g. a company address or a Twitter profile's selected location); and
3. the IP address if the item originated on a website, or the posting language if the source was a social media platform. In this case, the item was assigned to the country with the most speakers of that language, e.g. if the language was English and the geolocation and location were unknown, the hit was attributed to the United States.

The English language query had all 40 country filters applied to it, i.e. any matching results in English from any of the 40 countries were retrieved. For queries in languages other than English, geo-localization was applied only to countries with that language as an official language. For example, the German language query was appended only with the country filters for Germany and Switzerland.

C. Translating the queries

Query translation can be a challenging exercise, as each of the keywords should be interpreted in relation to one another but also in the broader context of the queries themselves. For instance, when translating the English word 'course' to French, it becomes 'cours', which can mean 'watercourse', 'you run', 'stock price', etc. In this particular case, a series of exclusions was developed to capture the content relating to 'course' in the broader context of education (more information is provided in Section D. Quality check).

The queries were translated into the 22 languages listed below, corresponding to the official languages spoken in the 40 selected countries analysed in this report. In cases where multiple official languages exist within a country, an assessment of online social media was conducted to exclude those languages that are rarely used by Internet users.

Figure 2.3: Languages covered in data collection

D. Quality check

To ensure the queries generated a high volume of relevant results, quality checks were performed: i) before developing the query (where each keyword is tested); and ii) during the extraction of data to check for outliers due to noise (often translating into very high results).

For instance, the filter on *Innovation* included 'modern*' as a keyword, which triggered some noise (results for the COVID-19 vaccine producer, 'Moderna'). This was therefore corrected to 'modern'.

In addition, since the topic of 'certificates of vaccination' only became prevalent during the latter months of the study period, the keyword 'certificate'—originally related to the field of education—was redefined in the query. Thus, keywords/terms such as 'vaccination certificate' and 'proof of vaccination' were excluded to remove noise in the education-related results.

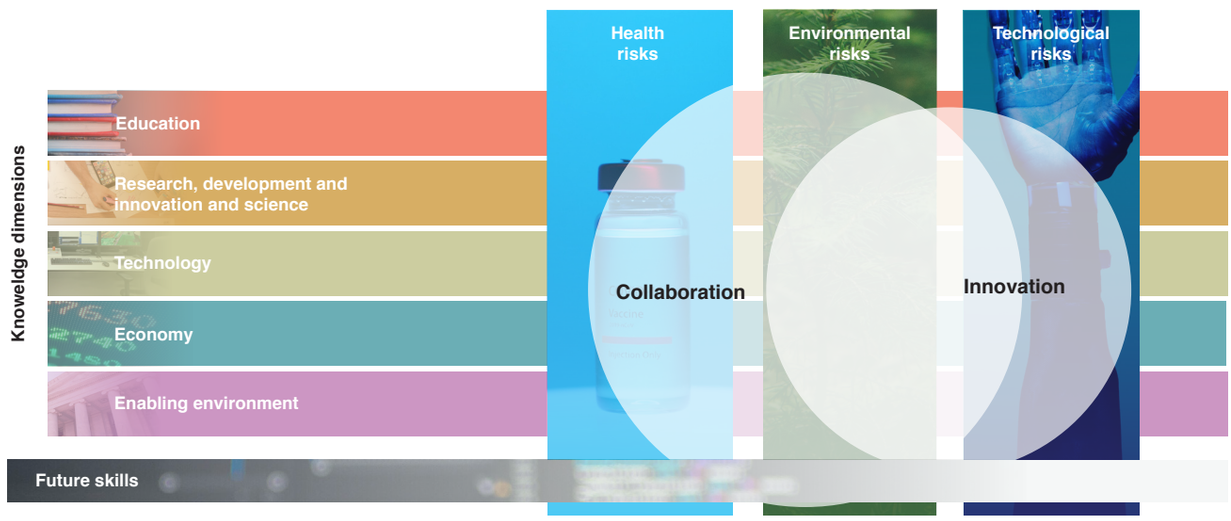
Also, the query design stipulated that a set of keywords must appear within a certain defined number of words from another set of keywords—at a distance of ten words or less, depending on the keyword in question.

Further quality controls were performed for countries featuring particularly high shares of mentions related to transformative capacities to investigate possible bias or identify errors. These controls cover: i) the number of collected mentions over time; ii) a review of the translations of the queries, and collaboration and innovation text filters; and iii) a review of the most active sources (websites) and authors of mentions related to transformative capacities (see more information in the section on limitation).

2.3 CONSTRUCTION OF THE 'TRANSFORMATIVE CAPACITY MODEL'

This report leverages big data to investigate the transformative capacities of countries to address future risks relating to health, the environment and technology. To this end, a transformative capacities model for future-ready societies was developed, as illustrated in Figure 2.4.

Figure 2.4: The transformative capacity model for future-ready societies



This model is based on three key components. The first relates to *future risks*, and more specifically to health, environmental and technological disruption risks, which—as discussed in Chapter 1—are major global challenges going forward. The second component comprises the *knowledge dimensions and future skills* that constitute the knowledge infrastructure of a country. Based on the Global Knowledge Index (GKI) framework,[15] this report identifies education, research, development and innovation (RDI) and science, technology,[16] economy, and enabling environment as the cornerstones of knowledge infrastructure that can generate impactful solutions to the global risks in focus. 'Future skills' was added to these five knowledge dimensions, as it is recognized as a key element that allows a country to adapt and respond to exogenous changes (see Chapter 1 for more information). The third component reflects *collaborative and innovative capacities* (together they represent transformative capacity), which are key enabling factors for the utilization of the knowledge dimensions and future skills.

The application of this model follows a two-step approach. In the first step, the model generates data concerning variations in the public's awareness across countries relating to publicly available online content discussing the intersection of global risks (health, environmental and technological) with knowledge dimensions and future skills. In doing so, the report provides an understanding of the extent to which knowledge dimensions and future skills are perceived as important means to respond to future risks. In a second step, the model applies a text filter to identify the share of online activity referring to transformative capacities (collaborative or innovative). The results generated by this model reflect the transformative capacities of countries by assessing the extent to which they are prepared to leverage these when utilizing knowledge dimensions and future skills in their responses to future risks.

2.4 MEASURING THE TRANSFORMATIVE CAPACITIES OF COUNTRIES IN THE CONTEXT OF ADDRESSING FUTURE RISKS

The query results quantify the mentions and levels of engagement relating to a given topic. These are used to assess the transformative capacities of countries.

*The **number of mentions** of a specific topic (i.e. the number of times a specific set of keywords assumed to define a specific topic are mentioned online).*

*The **level of engagement** with a specific topic (i.e. the number of times an online publication has been liked, shared or commented on).*

The reason why the level of engagement was included is that not all mentions generate the same interest, and hence interactions/dissemination. In this context, using data on engagement received by a mention allows a better understanding of the size of the population that accessed the information provided in a given mention. It is therefore particularly useful to go beyond the number of mentions and examine the level of engagement to highlight some of the mentions that contribute most to populations' awareness, and ultimately countries' capacities.

In using these two metrics, this report recognizes—in line with existing literature—that preparedness for future risks goes beyond the existence of national infrastructure. Rather, it is a function that involves entire societies and relies on the active participation of local communities.[17] More specifically, it recognizes the importance of two key processes in shaping and influencing knowledge creation: socialization and combination.[18] The former refers to the transfer of tacit knowledge between individuals through interactions, experiences and observations. The latter focuses on the conversion of explicit knowledge into more complex sets of knowledge, where knowledge is combined and processed to form new knowledge—according to the extent of development of the knowledge communication and diffusion process.[19] Therefore, building on the previous editions of the Future of Knowledge series, this report recognizes that these two factors (socialization and combination, which contribute to knowledge creation, communication and dissemination) can act as proxies for a community's capacity to effectively respond. In this context, this report uses the number of mentions and levels of engagement to measure the current knowledge socialization, communication, dissemination and combination in a given country.

However, raw mentions and engagement volumes can be misleading, and may be driven by the size of a country's population rather than by how active the population is online (see Table 2.2).

Table 2.2: Proportion of Internet users for the countries analysed

Country	Year	Individuals using the Internet (percent of population)[1]	Total population (in thousands)[2]
Australia	2017	87%	19,898[3]
Bangladesh	2019	13%	163,046
Brazil	2019	74%	211,050
Cameroon	2017	23%	24,566
Chile	2017	82%	14,772[3]
Egypt	2019	57%	100,388
Ethiopia	2017	19%	106,400
Finland	2019	90%	5,532
France	2019	83%	65,130
Germany	2019	88%	83,517
Ghana	2017	38%	29,121
Greece	2019	76%	10,473
India	2018	20%	1,352,642
Indonesia	2019	48%	270,626
Japan	2019	93%	126,860
Jordan	2017	67%	9,786
Kazakhstan	2019	82%	18,551
Kuwait	2019	100%	4,207
Lebanon	2017	78%	6,819
Luxembourg	2018	97%	604
Malaysia	2019	84%	31,950
Mexico	2019	70%	127,576
Morocco	2019	74%	36,472
Netherlands	2019	93%	17,097
Poland	2019	80%	37,888
Russian Federation	2019	83%	145,872
Rwanda	2017	22%	11,981
Saudi Arabia	2019	96%	34,269
Senegal	2017	30%	15,419
Singapore	2019	89%	5,804
South Africa	2017	56%	57,010
Sweden	2020	95%	10,099
Switzerland	2019	93%	8,591
Tajikistan	2017	22%	8,880
Tanzania (United Republic of)	2017	16%	54,660
Turkey	2020	78%	84,339
United Arab Emirates	2019	99%	9,771
United Kingdom	2020	95%	67,886
United States	2018	88%	327,096
Viet Nam	2019	69%	96,462

Notes: 1. ITU, 2020b; **2.** UN DESA, 2019b; **3.** Population aged 15+.

For this reason, this report uses mention density, engagement density and the share of a given dimension in total mentions or engagement to discuss the degree of awareness within a country.

Box 2.1: Definitions of mention density and engagement density

The mention density expresses the frequency of content generation on a given topic within a predefined time period, controlling for the size of the Internet-using population. A higher level of mention density signals a more active content-generating Internet community. This is calculated by dividing the total number of mentions by the size of the Internet-using population.

The engagement density expresses the frequency of engagement in the form of likes (or reactions), shares and comments with the mentions relating to a given topic within a predefined time period. A higher level of engagement density shows higher interest of the online community in a given topic. This is calculated by dividing the total number of engagements by the total number of mentions.

The 'share in total', expresses the distribution of total online activity (whether the activity is mentions or engagement) concerning a given topic (in the context of knowledge dimensions and future skills). For both knowledge dimensions and future skills, the 'share in total' function is used as a descriptive metric to better understand the focus of the public during the different phases of a crisis (e.g. the COVID-19 pandemic) or to better appreciate perceptions related to the threats posed by each of the global risks. For the collaborative and innovative capacities, the 'share in total' function is used as a performance metric. This report assumes that those countries that display a higher share of collaborative or innovative capacities today— with respect to a certain global risk — will show higher preparedness in addressing the impact of future risks.

To contextualize country performance in terms of preparedness, this report uses a relative metric based on the distribution of countries' performances with respect to awareness. Awareness is calculated as a composite index based on mention density and engagement density values (for each country over the two-year period under consideration) that follows the methodology of previous reports. For each knowledge dimension/future skill and capacity mix, the countries' performances in terms of awareness were ranked. Visually, this ranking is expressed using a five-star scale. The number of stars signals the quintile position of a country with respect to the dimension in question. For instance, a country with five stars on health risk/collaborative capacity/economy ranks within the top quintile of the distribution and is part of the best equipped group in terms of the degree to which collaborative capacities are seen as important in leveraging the economy (e.g. access to finance) to respond to the adverse effects of health risks.

The same approach is used to rank relative awareness performance in relation to collaborative and innovative capacities by aggregating all knowledge dimensions and future skills. The overall transformative capacities performance is also visualized by ranking the performance of the countries within the awareness index, based on the sum of the mentions and engagement relating to collaborative and innovative capacities.

The performance level intervals may change from one time period to another, based on the degree of difference in awareness-based preparedness across the sampled countries. To produce global aggregates, the values for all 40 countries (corresponding to the metrics selected for this report—e.g. mention and engagement densities, shares in total mention, etc.) were combined.

To employ the above metrics and generalize from the Internet-using (to the entire) population, this report adopts a series of assumptions:

- *Assumption 1:* A higher number of mentions, given a fixed size of Internet-using population, is equivalent to higher awareness, as captured by content creation dynamics.
- *Assumption 2:* A higher level of engagement, given a fixed number of mentions, is equivalent to higher awareness as captured by the interest the online population shows in a given thematic group of mentions.
- *Assumption 3:* There are no country-specific (time fixed) factors (such as high risk of flooding) that can drive a country's awareness with respect to a given global risk, or a country's awareness-based preparedness.
- *Assumption 4:* The active Internet-using population (content generators and engagers) can be regarded as a representative sample of the country's population.

Assumptions 1, 2 and 4 are necessary because they allow for metric relevance, as in the capacity to fully observe the relative degree of awareness of a given population concerning a topic through these two metrics, which have been derived through online and social media analysis. This implies that no other unobserved channel of information exchange and dissemination exists that could describe a country's risk awareness and awareness-based risk preparedness (as described by collaboration- and innovation-focused online content). Assumption 3 is necessary for comparison across countries; it implies that all countries are expected to experience a similar need for global risk awareness.

Finally, this report discarded the option of capturing information on the sentiment surrounding a specific mention (i.e. "overall attitude associated with the context in which a specific set of keywords appears, which can be either positive, neutral or negative").[20] This decision was motivated by two main factors: i) the research posed in this report is inherently complex, presenting several dimensions, capacities and risks—while sentiment analyses are more often used to address simpler issues/questions; and ii) there is no rigorous way to define what is positive and what is negative, especially given the complexity of the research tests' result—which sometimes indicated, for example, sentiment contrary to the nature of the article and/or a neutral attitude to positive or negative content. Future research will work towards improving the consistency of the sentiment identification strategy.

2.5 LIMITATIONS OF THE APPROACH

A number of limitations highlighted in the 2018 and 2019 reports remain relevant, as the methodology is similar in several respects. Box 2.2 presents the main limitations; for more information, please refer to the previous reports.[21,22]

Box 2.2: Limitations of the adopted approach

Events unrelated to future risks
Major events unrelated to future risks will indistinctively drive online activity within a country. For example, the tensions between Donald Trump and Greta Thunberg at the UN Climate Action Summit had an important effect on global online discussions in 2019–2020. That said, while this event generated a heightened level of activity, this does not directly imply specifically higher transformative capacities in a given country.

Elections and teacher shortages
Depending on the sampling period, the online activity for certain countries may be driven upwards due to specific situations and therefore inflate results above their real value. For example, elections—both national and local—and teacher shortages can introduce bias in the score of a country by inflating the results of the country for a given period.

Biases in automatic geo-localization
The methodology does not consider the impact of 'monopoly power' users and the determination of author/site location. Identifying the exact location of public web and social data is often difficult. The Digital Intelligence Platform runs through various criteria to determine the origin of a post or an article based on the information available (i.e. geo-coordinates when enabled on social media posts, profile location on social sites, contact details on business sites, domain and geo-IP for sites with no indication of location or geography).

Data noise
Noise from linguistic idiosyncrasies also potentially inflates results upwards. However, there is a little evidence of such data noise in the sample that could be a challenge for text mining. The main linguistic challenge concerns future skills; as there is a high use frequency of relevant keywords in everyday discussions, this inflates the results for this field in all countries.

Press freedom
Press freedom has a dual effect on country results. Suppression of freedom of speech leads to a reduced number of mentions and engagement, suggesting that individuals may not discuss technology/future skills adoption online. In this case, the methodology underestimates the true value of awareness, which is not reflected through online activity.

In addition, other limitations can be highlighted. The first refers to one of the assumptions used in this report—i.e. that the online/social media activity (and hence the level of awareness of, and preparedness for, future risks among the online community) is reflected in the general population of a country (including those without access to the Internet). In practice, this means that the awareness and preparedness of a country's online community is the same as those of the country's general population (whether or not they have access to the Internet). The accuracy of this assumption also has an impact on comparisons of performance across countries. Nonetheless, such an approach/assumption can also be found in academic studies, as highlighted in Section 2.2.1: Using social media to measure transformative capacities.

The second limitation relates to the fact that exogenous factors, such as climate disasters, often influence the level of awareness of a country's population towards specific risks and the solutions that can be leveraged to address them. In this regard, a population that has experienced several exogenous factors—whether relating to technology, environment or health—in a given timeframe may be more aware than another country's population that did not experience these exogenous factors. Thus, sampling two years rather than one may compensate for some of the country-specific idiosyncrasies. The added value of this approach is that it allowed the study to capture the impact of the COVID-19 pandemic, which affected all countries to a different extent.

The third limitation refers to data availability (in terms of mentions). This is the case for one country, Tajikistan, for which a significant number of dates had either very few mentions or none at all. As a result of this sampling inconsistency, when calculating the shares of mentions related to collaborative and innovative capacities, Tajikistan may feature extremely positive or negative results (0 percent and 100 percent), which are clear outliers in comparison to other countries. This is less due to the content captured and more to the fact that the number of mentions over time is extremely low or close to zero. Therefore, in order to avoid misleading the reader and keeping the analysis as robust as possible, only calculations that simply visualize the distribution of the mentions were considered (and not the shares, as in the case of transformative capacities).

Lastly, as in the previous Future of Knowledge reports, a sub-sample of the data matching the queries was extrapolated to represent the whole-data results generated by countries. This concerned 13 countries including the United States; for which a sub-sample of 5 percent was collected, while a sub-sample of 15 percent was collected for Australia, Brazil, France, Germany, India, Indonesia, Japan, Mexico, the Russian Federation, Turkey, the United Kingdom and Viet Nam. The sub-sampling was motivated by the technical limitations experienced with the social listening tool that prevented the collection of a larger amount of data.

ENDNOTES

1. UNDP and MBRF publish the Global Knowledge Index each year, tracking the performance of countries in seven sectors, namely: pre-university education; technical and vocational education and training; higher education; research, development and innovation (RDI); information and communications technology (ICT); economy; and enabling environment. The index is available at https://knowledge4all.com/admin/GKIReport/GKIReport2021-Methdology.pdf.
2. The Hays Global Skills Index, produced in conjunction with Oxford Economics, is a detailed report examining the global skilled labour market that puts into context the challenges employers face as they compete for the most sought-after skills. This 2019/2020 report, the eighth edition to date, uses a unique index to assess the magnitude of the challenges facing labour markets across 34 countries. The full report is available at https://www.oxfordeconomics.com/recent-releases/The-Hays-Global-Skills-Index-2019-2020.
3. See Dufty, 2015.
4. See Saud, Mashud and Ida, 2020.
5. Abdul-Baki and others, 2020.
6. Alnasser and others, 2020.
7. See Mulder, 2006.
8. Instagram content is primarily visual, which would necessitate another approach to data collection.
9. See WHO, 2020b.
10. See WHO, 2020d.
11. See UN, n.d.-c.
12. See WHO, 2020a.
13. UN, 2017.
14. UNEP, 2021a.
15. UNDP and MBRF, 2021.
16. Based on the previous editions of the Future of Knowledge series, the transformative capacity model for future-ready societies makes a distinction between technology as a knowledge dimension and technological risks. Technology as a knowledge dimension builds on the Global Knowledge Index and refers to the necessary technological infrastructure (e.g. data centers) and ICT that facilitate knowledge exchange and the development of new technologies. Technological risks refer to the disruptions generated by the four following digital technologies: AI, biotechnology, blockchain and cybersecurity.
17. See Mulder, 2006.
18. Nonaka and Takeuchi, 1995.
19. UNDP and MBRF, 2019b.
20. Ibid.
21. UNDP and MBRF, 2018.
22. UNDP and MBRF, 2019b.

03

GLOBAL ANALYSIS

03 GLOBAL ANALYSIS

Based on the transformative capacity model described in the methodology presented in Chapter 2, some 47.5 million data points[1] for mentions and engagement were collected between June 2019 and May 2021, serving as the basis for the global analysis of transformative capacities.

This analysis begins by presenting global results for transformative capacity. Sections 3.2.1 and 3.2.2 then analyse how the two sub-components of transformative capacity—namely collaborative and innovative capacities—are perceived as key assets in leveraging knowledge dimensions such as education, RDI and science, technology, economy and enabling environment, and future skills.

3.1 INTRODUCTION

Before delving into the analysis of transformative capacity, it is important to describe some of the key trends in the level of awareness concerning the role of resilient and sustainable knowledge dimensions, and future skills, in addressing health, environmental and technological risks. During the period of study, the highest levels of awareness recorded related to health risks in the context of knowledge dimensions and future skills, accounted for 44.38 percent of total mentions. Environmental and technological risks accounted for 33.51 percent and 22.11 percent, respectively, of the total number of mentions globally.[2]

Figure 3.1: Total proportion of global mentions (%)

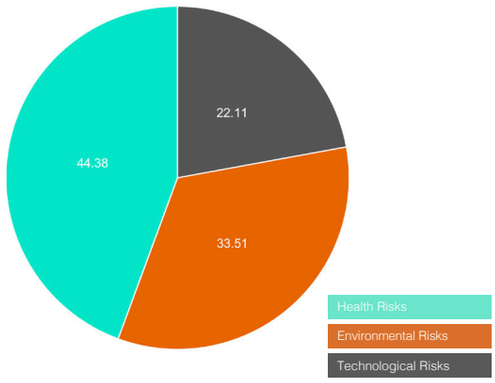
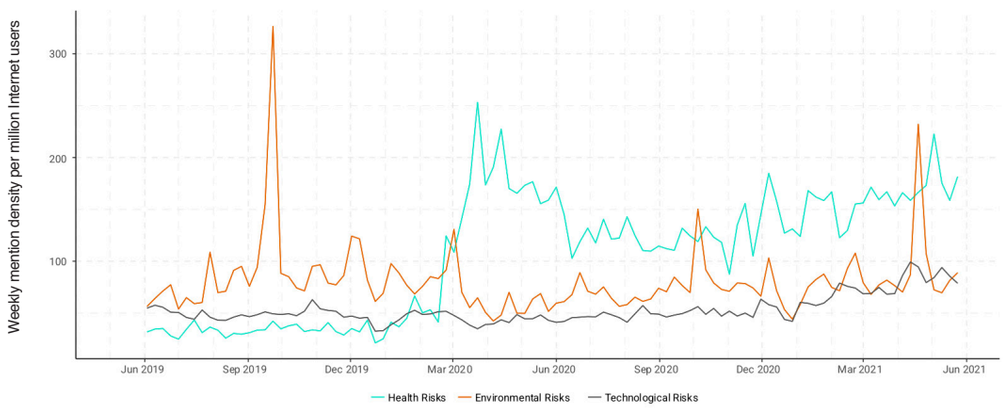


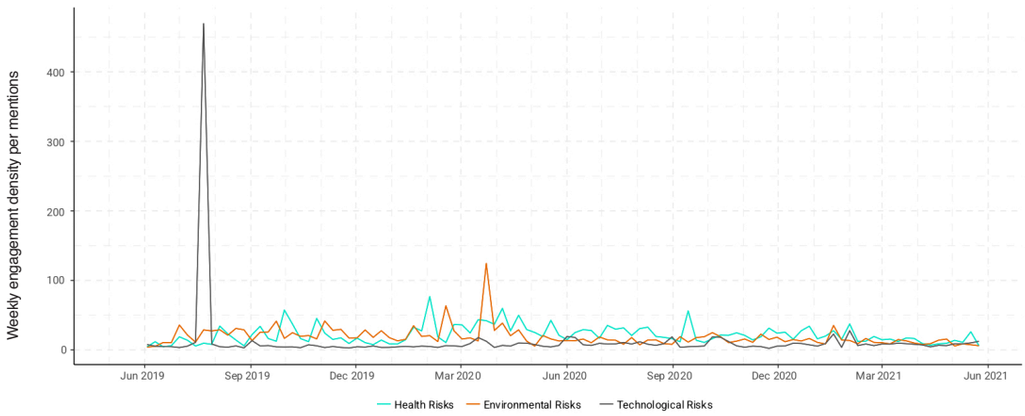
Figure 3.2 illustrates the levels of awareness within the 40 countries studied. In this figure, levels of awareness are measured by determining the average mention density relating to all risks within the context of knowledge dimensions and future skills. The levels of awareness increased from June 2019 to May 2021, although to different degrees for each risk factor. Overall, the countries studied perceive knowledge dimensions and future skills as increasingly relevant capabilities in addressing future risks. Average mention densities stood at 107, 81 and 53 weekly mentions per million Internet users for health, environmental and technological risks, respectively. Generally speaking, levels of awareness were lowest for all three risks studied at the start of the data collection in June 2019 and had considerable increases across the study period.

Figure 3.2: Global mention density over time



In Figure 3.3, awareness levels are measured according to the average density of engagement per mention relating to all risks in the context of knowledge dimensions and future skills. The figure shows that levels of engagement remained fairly stable between June 2019 and May 2021. Average engagement density stood at 21, 18 and 12 weekly engagements per mention for health, environmental and technological risks, respectively. This variation reflects the different natures of the risks. For instance, the level of engagement concerning health risks increased following the onset of the COVID-19 pandemic. The increase is partly due to the fact that social and online media were often leveraged to distribute information about the pandemic—e.g. relating to vaccinations, tests or government measures implemented to mitigate its impacts. Environmental risks were also increasingly discussed following high-level events and benefited from broader media coverage than technological risks. The latter are often discussed in economic and political contexts, and tend to affect society indirectly, which may explain the moderate level of engagement for technological risks.

Figure 3.3: Global engagement density over time



Awareness of environmental risks in the context of knowledge dimensions and future skills remained relatively high throughout the study period, largely driven by the growing number of events related to climate change[3] and consequent policy responses.[4] For instance, by 2019, EU Member States had already adopted or were planning to adopt more than 1,900 national policies and associated measures to decrease greenhouse gas emissions and meet climate objectives—notably by supporting energy efficiency and renewable energy goals—representing a 27 percent increase in the number of national policies and measures compared to 2017.[5] Mention density peaked during the week of 20–27 September 2019 during the Global Week for Future,[6] and specifically on 20 September, when the largest climate protests were held worldwide,[7] and 23 September, when activist Greta Thunberg delivered her speech at the UN Climate Action Summit.[8,9] Peaks in engagement density were also driven by high-level events such as COP 25 in Madrid[10] and the Leaders' Summit on Climate organized by US President, Joseph Biden, in April 2021.[11] In addition, the numerous denouncements of environmental regulations by former US President, Donald Trump,[12] and the inaction of Brazilian President, Jair Bolsonaro, in addressing climate change and environmental challenges also generated significant online engagement.[13]

Rising mention and engagement densities indicated a dramatic increase in awareness of health risks in the context of knowledge dimensions and future skills from the first quarter of 2020 onwards with the onset of the COVID-19 pandemic. Social media and online activity have also focused on collaborative and innovative means to address the implications of these risks over the study period. For instance, numerous online discussions emerged concerning how international collaboration was needed to develop a vaccine[14] to fight the pandemic or to accelerate the manufacturing and delivery of vaccine doses.[15]

Awareness of technological risks in the context of knowledge dimensions and future skills was the lowest in terms of average mention density among the risks studied. Nevertheless, that awareness showed steady growth over time, driven by rising use (and misuse) of new technologies (such as AI)[16] and the growing number of cyberattacks (and their impacts)[17] throughout the study period. In terms of engagement, the peak observed in the summer of 2019 coincided with the announcement of a new European Cybersecurity Competence Centre (ECCC). Through the ECCC, the EU is seeking to fight the increasing number of cyberattacks by improving cyber-resilience, supporting cybersecurity research and stepping up technological development efforts across the EU.[18] Overall, however, discussions on the broader impacts of climate disasters and the coronavirus pandemic generated more discussions than technological risks over the period.

3.2 TRANSFORMATIVE CAPACITIES

This report aims to: i) analyse the extent to which transformative capacities are perceived as important in leveraging knowledge dimensions and future skills to address global risks; and ii) provide a better understanding of the extent to which countries around the world are ready to mobilize their collaborative and innovative capacities to address future challenges.

The global share of mentions related to transformative capacities stood at 27.18 percent overall throughout the study period. This indicates the general perception that limited importance is allocated to transformative capacities in addressing risks. Of these global mentions, collaborative capacities accounted for 15.12 percent of mentions and innovative capacities for 12.06 percent. This suggests that, generally speaking, the economies studied view collaborative capacities as more relevant assets in tackling future risks.

Figure 3.4: Global share of mentions related to transformative capacities (all risks aggregated) (%)

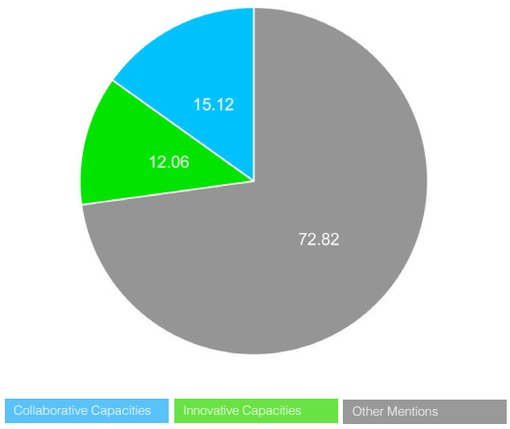
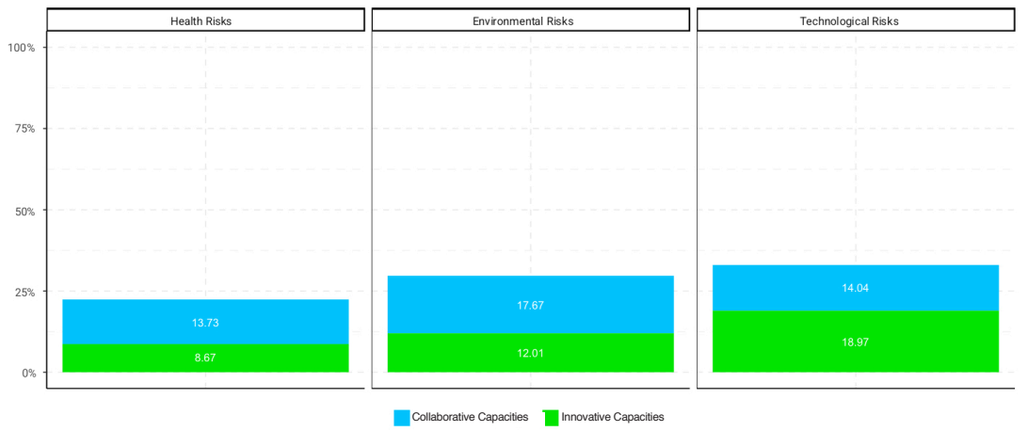


Figure 3.5 presents the global share of mentions by risk for each transformative capacity (collaborative or innovative). It shows that awareness of the potential of transformative capacities seems to be highest for technological risks—with 33.01 percent of mentions relating to collaborative and innovative capacities. The awareness level for environmental and health risks is slightly lower, with 29.68 percent and 22.4 percent of mentions, respectively.

Figure 3.5: Global share of mentions related to transformative capacities by risks

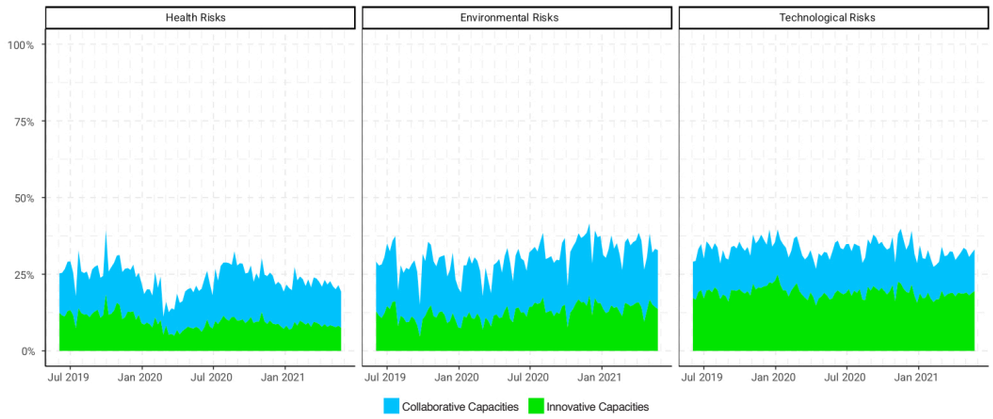


Countries perceive collaboration as a more relevant means to leverage knowledge dimensions and future skills to address environmental and health risks, whilst the level of awareness concerning innovative capacities is higher in relation to technological risks. This difference may be explained by the nature of the risks considered. The environment and health are essentially universal concerns, the risks of which are shared globally; hence, effective solutions to tackle these risks often rely on cooperation between different countries and actors at the global, regional, national and sub-national levels. Technological risks and disruptions, on the other hand, tend to be considered on a national basis. In addition, technology is mostly driven by private companies for which innovative capacity is a key differentiator; this helps to explain why innovative capacities are perceived as more relevant in addressing technological risks.

Mirroring these findings to some extent—and the variations observed in the awareness of the importance of leveraging innovative and collaborative capacities in mitigating risks related to knowledge dimensions and future skills—transformative capacities fluctuated over time for all risks. More specifically, capacities related to technological and environmental risks rose by 4 and 5 percent, respectively, from 3 June 2019 to

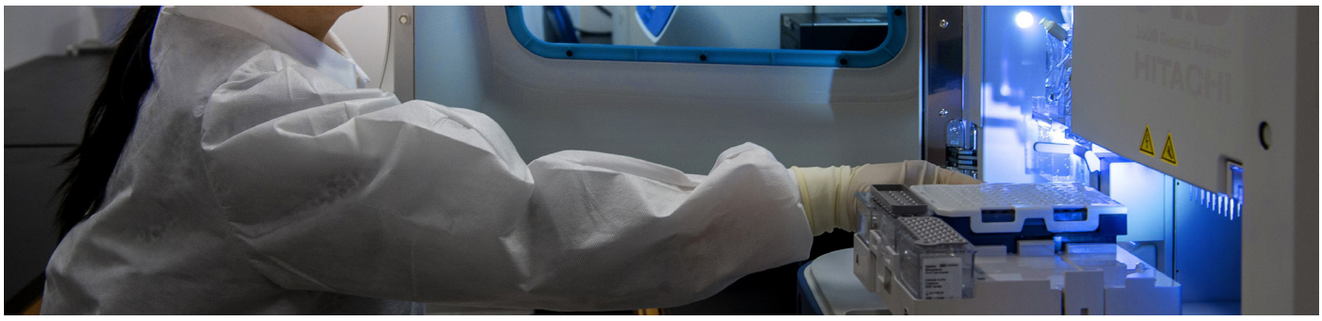
30 May 2021. Conversely, transformative capacities that leverage knowledge dimensions and future skills to respond to health risks saw a slight decrease, from 25 percent on 3 June 2019 to 19 percent on 30 May 2021. Generally, the fluctuations in transformative capacities are more pronounced for collaborative than for innovative capacities.

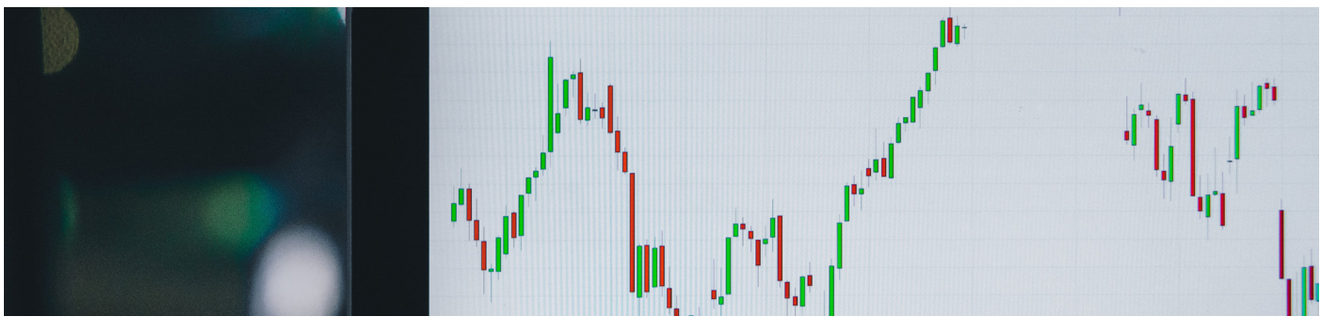
Figure 3.6: Fluctuations in global mention shares for transformative capacities by risk over time



The variations in the level of awareness of collaborative and innovative capacities over time are relatively limited for technological risks. This indicates that changes in transformative capacities are relatively slow, with a slight awareness level difference between collaborative and innovative capacities over time. Awareness of transformative capacities related to health risks saw significant fluctuation following the advent of the COVID-19 pandemic in February–March 2020. Notably, there was greater awareness of collaborative capacities as a means to leverage knowledge dimensions and future skills to address future risks.

Overall, the results show that there is increasing awareness of the role of transformative capacities in relation to knowledge dimensions and future skills when addressing future risks. In this sense, the global overview tends to indicate that countries are not fully prepared to respond to future risks, as illustrated by the COVID-19 pandemic. However, the lessons learned from this crisis should be considered going forward to ensure future risks cause fewer disruptions for economies and societies, and especially those that are most vulnerable. Sections 3.2.1 and 3.2.2 of Chapter 3 present the findings in more depth for each of the transformative capacities (collaborative capacities in Section 3.2.1 and innovative capacities in Section 3.2.2). This chapter illustrates how these capacities shifted over time relative to health, environmental and technological risks. It also highlights the factors (events, conferences, policies, etc.) that potentially drove these trends.





3.2.1 COLLABORATIVE CAPACITIES

Among the key transformative principles of the 2030 Agenda for Sustainable Development and its Sustainable Development Goals (SDGs)[19] is the aim to leverage collaboration to ensure no one is 'left behind' by the development process. Collaboration can take many forms and occur among various types of stakeholders, and is a key factor in overcoming crises and securing a better and more resilient future.

Environmental risks—be they from climate change, pollution, biodiversity loss or over-exploitation of natural resources—should be approached in a holistic way (i.e. through collaboration), as they often have far-reaching impacts on economic, social and environmental systems. These collaborative endeavours take place at the global level, notably through the United Nations Climate Change Conference of the Parties (COP),[20] but also at the regional and national levels. Collaboration also takes place between and across sectors and actors (from the public, private and civil society sectors) including policymakers, businesses, young people and research institutions.

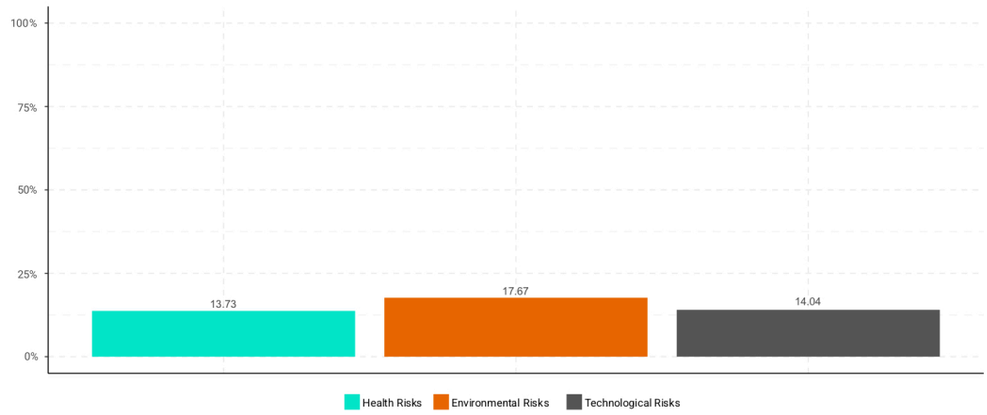
When it comes to health risks, the COVID-19 crisis has confirmed that collaboration is more essential than ever in addressing health challenges, and that efforts in this regard must not be constrained by national borders. International trade, tourism, transport and industrial development are on the rise in an ever more interconnected world, contributing to a rising risk of health crises and a subsequent demand for collaboration to ensure our preparedness and resilience. Rapid technological changes also cause unprecedented disruption and generate potential risks such as concentrations of digital power and widening digital divides. As our world is increasingly dependent on digital technologies, it is important to foster collaboration in the development and use of those technologies to ensure that they are harnessed ethically and for social good.

In this section, the evolution of awareness regarding collaborative capacities for addressing health, environmental and technological risks between June 2019 and May 2021 is analysed. The following section: i) presents an overview of the level of collaborative capacities for each of the risks in the context of knowledge dimensions and future skills; and ii) provides a detailed understanding of where collaborative capacities are perceived as key means to leverage specific knowledge dimensions and future skills.

3.2.1.1 Global trends in leveraging collaborative capacities to respond to risks

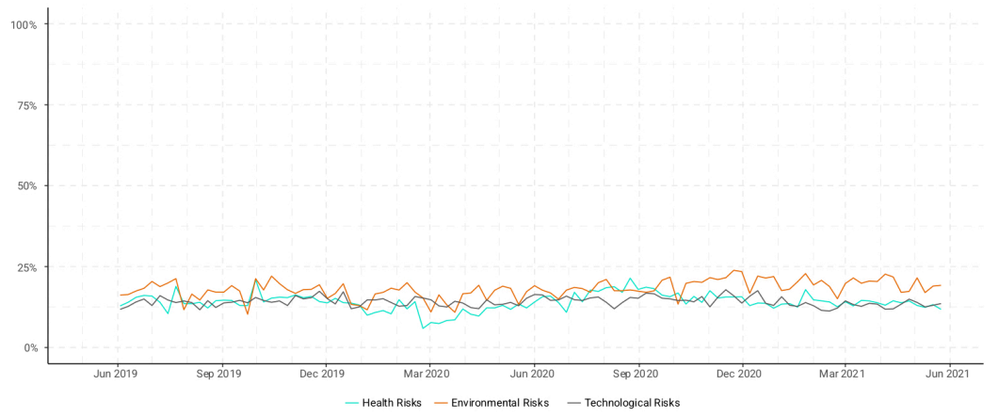
The analysis of online media activity reveals that between June 2019 and May 2021 (the period for which data has been extracted), there was a relatively low preparedness to leverage partnerships and cooperation to address future risks in the countries studied. Figure 3.7 shows that there is a higher awareness of collaborative capacities when it comes to addressing environmental risks (17.67 percent of total mentions). For health and technological risks, the level was relatively lower, with 13.73 percent and 14.04 percent of the total mentions relating to collaborative capacities, respectively. The lower percent of mentions of collaborative capacities in the context of health risks compared to the other two risks may be explained by the strong growth of online and social media activity on COVID-19 related news, which was not accompanied proportionally by collaboration-related news.

Figure 3.7: Global share of mentions related to collaborative capacities by risks



Looking at the evolution of mentions of collaborative capacities between June 2019 and May 2021, they remained globally stable for the entire period, with only some variation.

Figure 3.8: Global share of mentions related to collaborative capacities by risk over time



Mentions related to environmental risks observed a rising trend over the period (+3.9 percent) with various significant peaks throughout. While media articles consistently stress the urgency of joint action in addressing climate change,[21,22] a number of specific events generated an especially significant amount of online activity in the given period. For example, in September 2019, activist Greta Thunberg delivered an emotional speech at the UN Climate Action Summit,[23] "accusing world leaders of stealing her dreams and her childhood with their inaction on climate change"[24] and pleading for all nations to gather and urgently take collective action, as the "politics and solutions needed are still nowhere in sight".[25]

COP25, held in December 2019, also generated significant online activity, as nations faced a number of challenges, most notably in setting up an international carbon market and deciding how to compensate countries suffering from the worst impacts of climate change. The different interests between, *inter alia*, smaller nations, high-emitting countries and even businesses led to a number of issues being pushed to the next COP, illustrating the difficulties of collaboration for tackling climate change.[26]

December 2020 marked the five-year anniversary of the Paris Agreement,[27] the first universal climate change agreement committing all countries to join efforts to reduce greenhouse gas emissions and limit global warming, irrespective of their development level. While this agreement was a success for climate diplomacy and cooperation, it appears that the targets it set are highly challenging to meet, and that the world is currently headed for a temperature rise well above the agreed goals.[28]

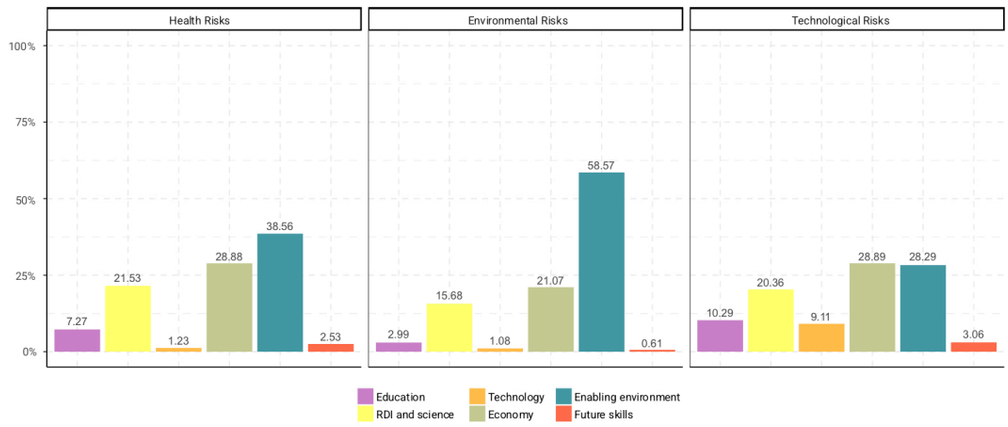
Ahead of COP26, due to be held in Glasgow in November 2021, the Biden Administration organized the 2021 Leaders' Climate Summit in April 2021, which also sparked online activity with regards to environmental risks and collaborative capacities. During this summit, "the US presented its goal of reducing emissions by 50–52 percent by 2030 compared to 2005 levels, which is also reflected in the nationally determined contribution (NDC) the US submitted to the UNFCCC [United Nations Framework Convention on Climate Change] on 21 April 2021, after re-joining the Paris Agreement".[29] This announcement was followed by pledges from many other global leaders. For example, Canada announced the increase of "its previous target to reduce emissions by 30 percent below 2005 levels by 2030 to a 40–45 percent reduction from 2005 levels by 2030".[30] The speech from the Brazilian President Jair Bolsonaro drew particular attention, given the massive fires in the Amazon forest in recent years. Despite a gesture towards positive climate action, this speech was criticized as "it did not raise ambition as needed, nor clearly state how and when Brazil will implement the targets and measures announced".[31]

Concerning health risks, although there were significant fluctuations in the two years covered by this analysis, the awareness of collaborative capacities related to health risks slightly decreased up to March 2020, at which point a more significant drop was observed owing to the proliferation of pandemic-related news in that period, which was not accompanied proportionally by collaboration-related news. Awareness of collaborative capacities related to health risks increased again progressively in the following months, to finally reach a similar level to that of June 2019 (-1.05 percent between June 2019 and May 2021). Since December 2019, the conversation has been mostly driven by the COVID-19 crisis, relevant public health strategies, depending on the evolution of the situation, as well as the collateral consequences of the crisis (notably addressed in The High-Level Event on Financing for Development in the Era of COVID-19 and Beyond convened by Canada, Jamaica and the United Nations in May 2020).[32] Online activity was also generated by announcements concerning the investments made in the development of the COVID-19 vaccine, and by the pharmaceutical sector as a whole, as well as by the support and collaboration among countries in facing the pandemic. For example, Cuban doctors were deployed in Italy in March 2020 to provide support to the country, which was hit hard by the pandemic.[33] Besides COVID-19, other collaboration-themed discussions notably include the announcement of a partnership worth over £980,000 between the United Kingdom's Medicines and Healthcare products Regulatory Agency, the Bill and Melinda Gates Foundation and the WHO "to improve the safety monitoring of medicines in low- and middle-income countries".[34]

Between June 2019 and May 2021, there was a rising trend (+1.8 percent) in the absolute value of mentions for global collaboration concerning technological risks. News related to accusations of racial bias in Facebook algorithms to allow advertisers to stop specific racial groups from seeing their ads contributed to a temporary increase in online activity. Since AI is created by humans, "systematic bias may arise as a result of the data used to train systems, or as a result of values held by system developers and users",[35] leading to risks such as discrimination. In light of these accusations, a coordinated action was launched by hundreds of businesses—such as Adidas and Coca-Cola—to remove their ads from Facebook.[36] This led Facebook to set up an internal investigations team in July 2020 to identify racial bias in the algorithms governing Instagram and Facebook[37] and ensure the ethical use of AI.

The remaining part of this section presents a deeper analysis of the data by providing insights on the knowledge dimensions and future skills for which collaborative capacities are seen as playing an important role. All risks depict a similar trend, whereby the top three dimensions for which collaborative capacities are seen as most important are: enabling environment, economy, and RDI and science.

Figure 3.9: Distribution of mentions of collaborative capacities by risk across knowledge dimensions and future skills



The enabling environment appears to be the knowledge dimension with the most significant share of mentions in the context of collaborative capacities when it comes to environmental and health risks, accounting for 58.57 percent and 38.56 percent, respectively, of mentions.

Concerning environmental risks, significant awareness concerning the enabling environment dimension was generated by the various high-level climate change events and conferences organized among global leaders, as well as political events addressing these pressing issues (such as the G20).

The economy dimension generated significant awareness under health risks, given the numerous cooperation initiatives to address the impacts of the COVID-19 crisis. For example, in March 2020, leaders of the G20 gathered for an extraordinary summit and "promised a united front in fighting the COVID-19 coronavirus, saying they were injecting over four trillion euros into the global economy to counter a pending global recession".[38] The High-Level Event on Financing for Development in the Era of COVID-19 and Beyond, co-convened by Canada, Jamaica and the United Nations, sought to find ways to focus on socio-economic recovery and pandemic financing needs.[39] Regional initiatives have also been set up to boost the recovery, such as the temporary instrument, the NextGenerationEU (NGEU) fund, aimed at supporting EU Member States hit by the COVID-19 pandemic, with a special focus on building a greener, more digitally advanced and resilient Europe.[40]

Concerning technological risks, the enabling environment is the second most prominent knowledge dimension in terms of share of mentions on collaborative capacities (28.29 percent), while economy attracted the most mentions for these risks (28.89 percent). With the advent of the pandemic, companies increasingly relied upon, and invested in, digital technologies, often with the support of the public sector. Against the backdrop of an increasing risk of cyberattacks in recent years, the digital transformation of companies needs to go hand in hand with investment in digital security to mitigate this risk. For example, Luxembourg's innovation agency set up the Fit 4 Resilience programme, providing support to companies seeking to reinvent themselves following the COVID-19 crisis, notably through the review and digitalization of their processes[41] (e.g. cybersecurity solutions accompanying the deployment of digital solutions).

Across the three risks, future skills and technology gathered the lowest share of mentions in the context of collaborative capacities with, respectively: 0.61 percent and 1.08 percent of mentions for environmental risks; 2.53 percent and 1.23 percent for health risks; and 3.06 percent and 9.11 percent for technological risks.

Box 3.1: Focus on collaborative capacities and future skills

As the boundaries between sectors become more porous and interdependencies increase in the context of the fast pace of globalization, collaboration has grown to become an essential paradigm to address risks and ensure sustainable development. As stressed by SDG 17 on partnerships for the goals, "the SDGs can only be realized with strong global partnerships and cooperation".[1] With collaboration and cooperation being essential for global growth, countries must place special emphasis on developing these soft skills among young people and their workforces as a whole.

While the analysis of online activity relating to collaboration mentions for the three risks reveals a significantly lower number of mentions related to future skills, a number of countries have taken steps to address risks through education and upskilling, such as India, Egypt, Germany and Saudi Arabia. As illustrated in the examples below, some of these education and upskilling initiatives are delivered through collaboration and partnerships within and between countries.

In India, the Government Mentor Programme, initiated by the Government of Telangana, intends to develop a culture of innovation among public officials and entrepreneurs by bridging the gaps between them. Through this programme, businesses benefit from a better understanding of government rules and processes, and develop skills to streamline their solutions. Meanwhile, government employees develop new innovation skills and perspectives by building upon private sector experiences, therefore identifying solutions that could be used in the public sphere.[2] Under this programme, the Hyderabad City Police collaborated with start-ups to devise innovative solutions to address challenges such as cyber-crime, crime prevention, traffic management, health management and road safety.[3]

Beyond the national context, India also leverages international partnerships to provide its workforce with specific skills. In April 2021, Indian Prime Minister Narendra Modi engaged with his Japanese counterpart, Yoshihide Suga, on the challenges caused by the pandemic and spoke about collaborating to build robust and diverse supply chains, including in the technology sector, and notably by developing new manufacturing and skills development collaborations.[4] The two leaders stressed the importance of operationalizing the 'Specified Skilled Workers' agreement previously signed in January 2021. This agreement enables Indian nationals who possess certain professional and language skills to seek employment in Japan, therefore encouraging the development of new skills and professional mobility.[5,6] Both countries, therefore, identified upskilling—through collaboration—as a key measure to mitigate the impacts of COVID-19 and ensure preparedness for meeting health or environmental risks.

In May 2021, Egypt set up a National AI strategy to prepare its population for the digital age. Through formal education and training, among other enablers, the strategy aims to help solve the country's challenges in line with the United Nations Sustainable Development Goals, and promote regional and international cooperation by championing initiatives and dialogues. The country seeks to apply AI to develop various sectors such as agriculture, manufacturing, health care and the environment.[7] For example, Egypt introduced a new plant that leverages AI for the rationalization of water use in the irrigation of cultivated areas, therefore enabling more effective planning of needs.[8] Conscious that upskilling is essential to the deployment of AI, Egypt is taking active steps to upskill its population. For example, the Ministry of Communications and Information Technology (MCIT) signed a Memorandum of Understanding (MoU) with IBM Egypt to equip more than 1,000 Egyptian students with AI skills to compete in the ICT global market.[9] This collaboration aims to prepare the country to leverage AI as a solution to tackle various challenges related to the environment and public health, but also to foster the necessary capacities to address potential issues linked to the development of AI, such as its unethical use.

In Germany, the endorsement of the Berlin Declaration on Education for Sustainable Development at the UNESCO World Conference on Education for Sustainable Development (ESD) generated substantial online activity. Adopted in May 2021, this declaration is the result of a fruitful collaboration between the 2,800 participants—from governments and international, intergovernmental and nongovernmental organizations to civil society, youth, the academic community, the business sector and all spheres of teaching and learning. The declaration notably highlights the need to implement ESD with a focus on cognitive skills, social and emotional learning, critical thinking, collaboration competences, and skills for problem solving, coping with complexity and risk.[10,11] The UNESCO programmes for the implementation of the Education for Sustainable Development for 2030 framework aim to provide learners with the necessary knowledge, values, skills and attitudes to contribute to sustainable development and support countries in developing and expanding educational activities in areas such as climate change, biodiversity, disaster risk reduction, water resources, cultural diversity, sustainable urbanization and sustainable lifestyles, thereby seeking to address both health and environmental risks collaboratively.[12] Global and regional networks of stakeholders from education and sustainable development communities will implement its ambitious education agenda. This will be facilitated through the ESD for 2030 Network (ESD-Net), which aims to establish and develop collaboration between a variety of actors. The UNESCO Associated Schools Network (ASPnet),[13] a global network of more than 11,500 educational institutions in 182 countries, also plays an important role as a laboratory for the development and implementation of ESD methods, and provides a network for those institutions to share good practices and build partnerships.

Notes: 1. UN, n.d.-d; **2.** See OPSI, 2018; **3.** RoyMoulik, 2019; **4.** The Indian Express, 2021; **5.** Chaudhury, 2021; **6.** Hindustan Times, 2021; **7.** Egypt, The National Council for Artificial Intelligence, 2021; **8.** Egypt Today, 2020; **9.** Egypt, Ministry of Communications and Information Technology, 2020; **10.** UNESCO, 2021; **11.** Global University Network for Innovation, 2021; **12.** UNESCO, 2019; **13.** UNESCO Associated Schools Network, n.d.

3.2.1.2 Country-level trends in leveraging collaborative capacities to tackle risks

Country-level trends in terms of the most discussed risks relating to collaborative capacities show that health (27 countries), environmental (10 countries) and technological (3 countries) risks received the most mentions.

Figure 3.10: Most discussed risks relating to collaborative capacities

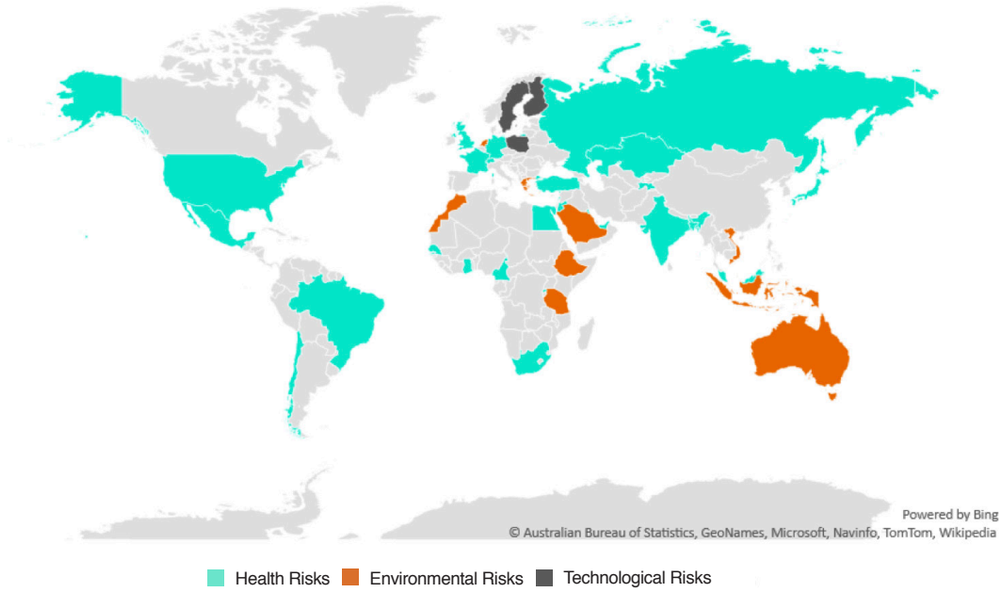


Table 3.1: Most discussed risks relating to collaborative capacities by country

Health		Environmental	Technological
Bangladesh	Malaysia	Australia	Finland
Brazil	Mexico	Ethiopia	Poland
Cameroon	Russian Federation	Greece	Sweden
Chile	Rwanda	Indonesia	
Egypt	Senegal	Luxembourg	
France	Singapore	Morocco	
Germany	South Africa	Netherlands	
Ghana	Switzerland	Saudi Arabia	
India	Tajikistan	Tanzania (United Republic of)	
Japan	Turkey	Viet Nam	
Jordan	United Arab Emirates		
Kazakhstan	United Kingdom		
Kuwait	United States		
Lebanon			

Note: The analysis illustrated in Figure 3.10 and Table 3.1 is based on the number of mentions (relating to a specific risk and collaborative capacity) relative to the total number of mentions (relating to a specific risk) within the given country.

In around two-thirds of the countries (27), collaborative capacities are the most discussed means to address health risks—as opposed to other risks. For example, in Russia, online activity regarding health risks and collaborative capacities was notably driven by the development of the Sputnik V vaccine[42] and the agreements made with various Chinese biopharmaceutical firms to manufacture the vaccine.[43,44]

In Lebanon, the receipt of the first batch of the AstraZeneca COVID-19 vaccine from the COVAX Facility in March 2021 drew significant online attention. COVAX is a joint initiative between WHO, Gavi, UNICEF and the Coalition for Epidemic Preparedness Innovations (CEPI) to ensure the equitable global distribution of COVID-19 vaccines.[45,46]

In 10 of the countries studied, a higher level of discussions on the role of collaborative capacities in addressing environmental risks was noted in comparison to health and technological risks. For instance, Eastern Australia experienced severe rainfall deficiencies over the period 2017–2019, leading to extensive droughts. After several months of wrangling over the government response to this environmental disaster, in November 2019 the Morrison government settled a $1 billion package to provide long-term support for drought victims.[47,48] The package included education funding to help schools in areas affected by the drought to provide financial relief to families to ensure continued school attendance.[49] In light of these extensive droughts, devastating heatwaves and consequent bushfires, the government has faced severe criticism concerning its climate change policies and inaction.[50,51]

As for the remaining three countries—Finland, Poland and Sweden—the role of collaboration was mostly discussed in relation to technological risks, rather than in relation to environmental or health risks. In Poland, the establishment of various cooperation agreements by the government with other countries to enhance cybersecurity contributed to the awareness of collaborative capacities in addressing technological risks. For instance, Poland and France signed a joint declaration on strengthening cybercooperation, with both parties committing to share information and cooperate on possible threats and occurrences resembling deliberate cyberattacks on public and economic sectors. Another agreement was signed between the Ministry of Digital Affairs in Poland and Thales, a French multinational technology company,[52] on the participation of the company in the Cybersecurity Cooperation Programme (PWCyber), which is a public–private partnership aiming at constantly strengthening Polish cybersecurity.[53] Also, in June 2019, military officials from the United States and Poland signed a cyberspace defence cooperation agreement to improve and facilitate military-to-military coordination (including information exchange) in terms of cybersecurity and to strengthen capabilities in this regard.[54]

Concerning awareness of the importance[55] of collaborative capacities in leveraging knowledge and future skills to mitigate the effect of future risks, health risks were the most engaging in 28 countries, followed by environmental risks (11 countries) and technology (one country) in the period between June 2019 and May 2021.

Figure 3.11: Engagement with risks relating to collaborative capacities

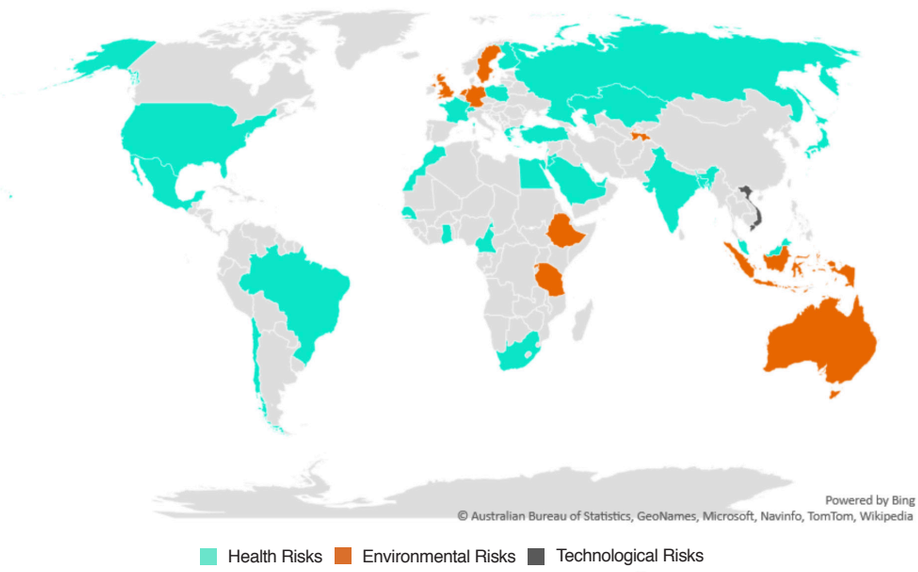


Table 3.2: Engagement with risks relating to collaborative capacities by country

Health		Environmental	Technological
Bangladesh	Lebanon	Australia	Viet Nam
Brazil	Malaysia	Ethiopia	
Cameroon	Mexico	Germany	
Chile	Morocco	Indonesia	
Egypt	Poland	Luxembourg	
Finland	Russian Federation	Netherlands	
France	Saudi Arabia	Rwanda	
Ghana	Senegal	Sweden	
Greece	Singapore	Tajikistan	
India	South Africa	Tanzania (United Republic of)	
Japan	Switzerland	United Kingdom	
Jordan	Turkey		
Kazakhstan	United Arab Emirates		
Kuwait	United States		

Note: The analysis illustrated in Figure 3.11 and Table 3.2 is based on engagement.

The engagement with risks relating to collaborative capacities by country mirrors, to a large extent, those observed in the global analysis on innovative capacities (Section 3.2). Following the onset of the pandemic, in most countries, engagement was highest in the context of health risks. This the case for the United Arab Emirates, which conducted a nationwide campaign in 2020 to disinfect public transport and facilities, which generated significant online engagement.[56] This was done in collaboration with relevant public sector agencies and relied on the collaboration of citizens, tourists and residents of the country. Other examples include cooperation between the government, private sector entities and citizens to tackle the pandemic's impact. For instance, the chairman of Al Habtoor Group, beyond providing the government with 50 ambulances, also committed to establishing a laboratory facility focusing on viruses and epidemic control, together with the health authorities and the Mohammed Bin Rashid University of Medicine and Health Sciences (MBRU).[57]

As well as country-level collaboration, the United Arab Emirates engaged in bilateral discussions with other countries in order to mitigate the impact of the pandemic (for example, with Pakistan) to communicate temporary visa restrictions and exchange knowledge about the challenges and repercussions of the COVID-19 pandemic.[58]

Health risks also received the most engagement in relation to collaborative capacities in Kuwait, which donated $3 million in medical supplies to China in March 2020 to support the country in its fight against COVID-19.[59] The Kuwait Fund for Arab Economic Development, commonly known as the Kuwait Fund—the country's official agency for the provision and administration of financial and technical assistance to developing countries—contributed $4 million to UNICEF's COVID-19 response in the Syrian Arab Republic in November 2020, aimed at supporting the most vulnerable children and families in facing COVID-19.[60]

As for collaborative capacities to tackle environmental risks, several examples of collaboration at the local, national and international levels were identified. For instance, three peaks of engagement were highlighted in Rwanda. The first relates to the city of Kigali, that was recently awarded with the 'Most Inventive Inclusive Prosperity Practice' award[61] as part of the Prosperity and Inclusion City Seal and Award.[62] This award recognizes the efforts of Kigali in upholding environmental protection values—reflecting a series of measures partly relying on citizen engagement, including bimonthly car free days. Inclusive cities are said to "nurture people's skills, creating an environment that expands opportunities for everyone regardless of status. They also attract talent with their infrastructure, competitive market conditions, collaborative opportunities, and lifestyle possibilities".[63]

Furthermore, in May 2020, Rwanda announced an updated climate action agenda including climate mitigation and adaptation measures. While this initiative is government-led, it relies on the Rwanda Green Fund,[64] it is expected to be funded by domestic, such as the Rwanda Green Fund, and external sources, thus involving a wide range of stakeholders in the fight against climate change.[65]

The third peak in engagement observed related to Rwanda's participation in the G7 summit in 2019, which provided an opportunity for Rwanda to discuss major global environmental challenges with other world leaders.[66] In this regard, the French Presidency of the Summit recommended strengthening collaboration, insisting on the need for "active mobilization of youth, and the need for concrete multi-stakeholder coalitions and projects involving countries, the business sector, scientists, non-governmental organizations (NGOs), youth, indigenous communities, cities and regions".[67]

The only country for which technology was the most engaging risk dimension was Viet Nam, largely owing to the previously mentioned controversial law on cybersecurity, which triggered a collaborative effort of opposition from foreign companies, activists and citizens seeking to ensure their data is protected from government access.[68,69]

The remaining figures and analysis in this section aim to provide a complete overview of countries' collaborative capacities for each of the considered risks in connection with knowledge and future skills, allowing for a comparison of their performances in this respect.

A. Collaborative capacities relating to health risks

Figure 3.12: Countries' awareness of collaborative capacities relating to health risks

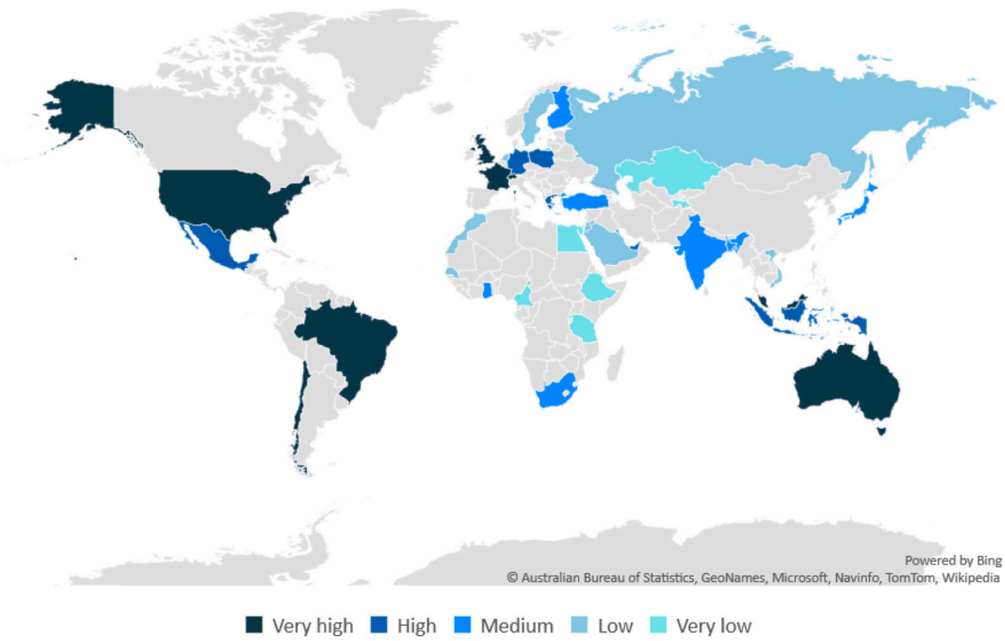


Table 3.3: Countries' awareness of collaborative capacities relating to health risks

Country	Mentions	Engagement	Awareness Index	Awareness Level
United Kingdom	219,367	18,269,607	78.96	Very high
United States	1,196,940	64,037,960	70.40	Very high
Brazil	226,207	21,132,980	64.49	Very high
Australia	85,120	855,187	55.34	Very high
Chile	50,427	1,139,166	53.96	Very high
Switzerland	31,298	236,627	43.52	Very high
France	102,900	4,350,520	41.63	Very high
Malaysia	12,453	831,074	40.16	Very high
Mexico	127,800	5,989,807	39.35	High
United Arab Emirates	33,906	233,195	38.97	High
Singapore	12,943	229,627	34.70	High
Luxembourg	1,560	13,118	31.25	High
Germany	144,753	1,503,973	25.27	High
Greece	14,700	68,975	21.08	High
Indonesia	116,893	2,622,133	20.93	High
Poland	20,479	496,820	19.54	High
Kuwait	1,529	45,870	19.49	Medium
South Africa	15,307	400,370	18.58	Medium
Turkey	88,173	265,480	15.01	Medium
Japan	72,193	1,077,920	13.95	Medium
India	136,227	2,226,487	13.56	Medium
Finland	1,743	29,196	12.26	Medium
Bangladesh	8,886	132,567	12.00	Medium
Ghana	4,068	60,538	11.43	Medium
Sweden	4,150	53,167	10.99	Low
Netherlands	9,842	82,956	10.50	Low
Saudi Arabia	25,208	99,358	9.63	Low
Viet Nam	57,233	28,887	8.76	Low
Russian Federation	41,627	363,127	7.89	Low
Jordan	3,966	4,405	6.47	Low
Morocco	7,419	51,552	6.21	Low
Senegal	2,300	5,053	6.00	Low
Rwanda	619	2,912	4.64	Very low
Lebanon	2,092	3,387	4.57	Very low
Egypt	21,212	22,243	4.02	Very low
Tanzania (United Republic of)	1,679	4,590	3.13	Very low
Kazakhstan	2,159	6,943	2.88	Very low
Cameroon	691	2,055	2.53	Very low
Ethiopia	489	1,411	1.51	Very low
Tajikistan	190	14	0.74	Very low

Note: Mentions and engagements are reported in absolute terms. In order to calculate the Awareness Index, we used a formula in which the two composites (mentions and engagement) were first standardized, then normalized and finally linearly combined. Please refer to Chapter 2—Methodology for more information about how the Awareness Index and awareness category level are calculated.

In Chile, the scientific and academic collaboration agreement reached between Pontificia Universidad Católica de Chile and the Chinese biopharmaceutical company, Sinovac Biotech Ltd., has been instrumental in the supply of vaccine doses and consecutive mass vaccinations in Chile. The vaccine developed by the Beijing-based laboratory has been assessed in trials in Chile which, in turn, has actively facilitated domestic access to this vaccine.[70,71]

France has also been actively collaborating through the COVAX mechanism to support access to vaccines for all countries. With an initial pledge of 500,000 doses, France became the first country to allocate doses of COVID-19 vaccines from its domestic stockpile to COVAX in April 2021. President Emmanuel Macron's pledge opened a new chapter for COVAX, in which high-income nations can donate doses directly to the global vaccine equity mechanism to complement doses acquired through partnerships with producers.[72] Throughout the pandemic, France has joined other countries in numerous collaborative and solidarity actions, such as the repatriation of citizens of the 26 EU countries—notably including a flight from China in early February bringing home 64 French citizens and 135 other EU citizens.[73] Some French patients were transferred to Germany, Austria and Luxembourg, and elsewhere, to be treated.[74] France has also collaborated with other countries by donating vital medical equipment, for example by sending 1 million masks and 20,000 protective suits to Italy, and delivering 400 oxygen masks, 200 nasal cannulas, generators, and other supplies to Mongolia in January 2021.[75]

Remarkably, the level of awareness of collaborative capacities in addressing health risks is very high in Brazil, which could be attributed to a series of activities such as the partnership agreement signed with the EU in order to fight COVID-19.[76] This agreement foresees the financing of research projects for diagnosis, treatment and vaccine development. In doing so, it hopes to support peer-to-peer learning, knowledge sharing, cooperation, dialogue and the exchange of experiences. Collaboration was also leveraged within the country, with private sector actors cooperating to combat COVID-19. For instance, Magnamed, the largest manufacturer of pulmonary ventilators in Brazil, received technical and engineering support from companies such as Positivo, Suzano, Klabin, Embraer, Fiat, White Martins and Flex to deliver 6,500 ventilators to the Ministry of Health.[77]

B. Collaborative capacities relating to environmental risks

Figure 3.13: Countries' awareness of collaborative capacities relating to environmental risks

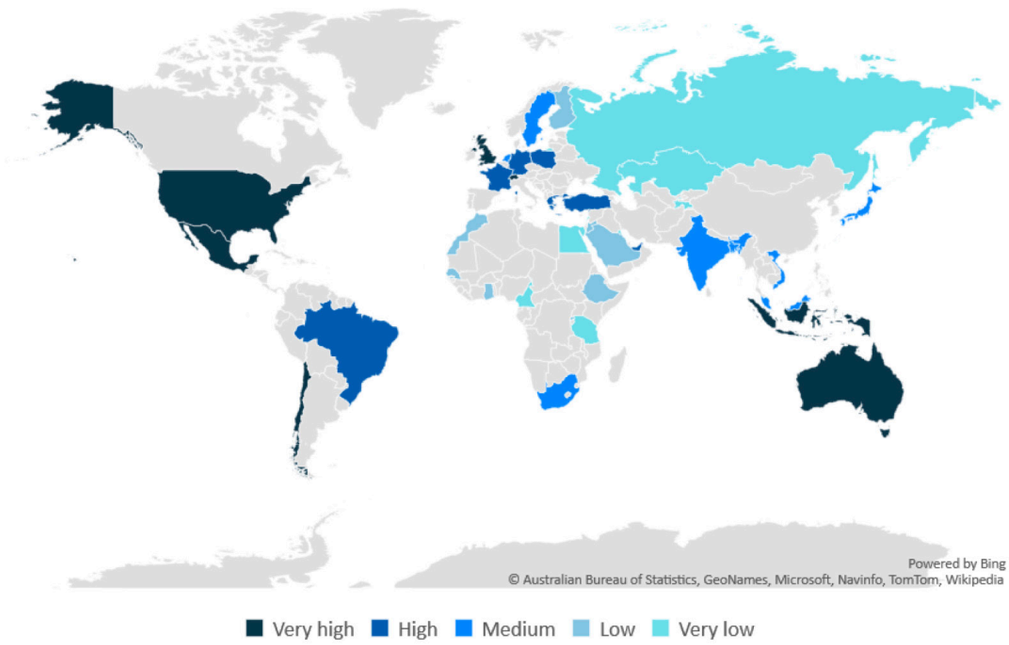


Table 3.4: Countries' awareness of collaborative capacities relating to environmental risks

Country	Mentions	Engagement	Awareness Index	Awareness Level
United Kingdom	161,553	18,460,887	66.96	Very high
Indonesia	946,320	24,245,560	61.14	Very high
Australia	112,200	2,262,800	53.15	Very high
United States	713,240	45,946,480	44.79	Very high
Luxembourg	2,380	21,094	31.36	Very high
Switzerland	27,928	170,648	26.26	Very high
Mexico	48,973	2,045,247	21.74	Very high
Chile	20,784	474,195	21.38	Very high
United Arab Emirates	26,257	150,419	20.75	High
France	88,560	1,669,733	19.12	High
Singapore	8,794	137,233	18.18	High
Germany	143,367	1,633,293	18.01	High
Greece	18,353	47,204	16.67	High
Brazil	88,433	2,130,040	14.12	High
Poland	14,145	217,583	9.60	High
Turkey	77,340	256,700	9.22	High
Sweden	5,637	61,238	8.48	Medium
Netherlands	11,169	92,445	8.10	Medium
Malaysia	6,394	79,178	6.73	Medium
Viet Nam	64,227	47,440	6.64	Medium
India	104,053	970,127	6.39	Medium
Bangladesh	8,101	70,109	6.11	Medium
Japan	29,133	297,327	5.84	Medium
South Africa	11,784	92,428	5.63	Medium
Finland	2,247	13,756	5.46	Low
Saudi Arabia	25,333	28,693	5.46	Low
Ghana	3,276	16,029	3.85	Low
Rwanda	510	3,004	3.60	Low
Jordan	3,013	3,324	3.32	Low
Morocco	8,599	28,943	3.32	Low
Ethiopia	662	4,450	2.85	Low
Senegal	1,410	3,135	2.76	Low
Tanzania (United Republic of)	2,159	5,004	2.38	Very low
Egypt	18,604	10,917	2.15	Very low
Russian Federation	16,013	55,847	2.11	Very low
Cameroon	645	2,051	1.84	Very low
Kuwait	834	1,112	1.62	Very low
Lebanon	887	736	1.18	Very low
Kazakhstan	1,083	432	0.34	Very low
Tajikistan	163	36	0.34	Very low

Note: Mentions and engagements are reported in absolute terms. In order to calculate the Awareness Index, we used a formula in which the two composites (mentions and engagement) were first standardized, then normalized and finally linearly combined. Please refer to Chapter 2—Methodology for more information about how the Awareness Index and awareness category level are calculated.

Among the countries analysed, Chile ranks among the highest in terms of awareness of collaborative capacities to tackle environmental risks. In December 2019, Chile held the presidency of the UN Climate Change Conference COP25 (2–13 December 2019), with logistical support from the Government of Spain. In April 2020, the country set forward more ambitious climate change adaptation and mitigation goals through the update to its NDC,[78,79] demonstrating its leadership and commitment in fighting climate change. These objectives will notably be achieved through reductions in overall emissions, mainstreaming targets in planning processes, a carbon budget, and substantial private sector engagement, therefore underlining the importance of collaboration with all actors within the country to achieve substantial results. Since 2019, Chile has incorporated a participatory process through public consultation in its NDC update process, seeking to ensure the engagement and collaboration of all types of national stakeholders in addressing environmental challenges.[80]

Throughout the study period, the United States also ranks among the best in terms of collaborative capacities to mitigate the impact of environmental risks. In January 2021, hours after taking office, President Joe Biden emphasized the need for partnership and cooperation to tackle global issues,[81] later resulting in the re-entry of the United States into the Paris agreement with a view to restoring the country's leadership in the fight against climate change.[82] The use of collaborative capacities to tackle environmental risks are also demonstrated within the country, where climate concerns are to be mainstreamed across all national and local agencies, mobilizing an 'all-government approach'.[83]

Indonesia is also among the countries with a high rank in the awareness index in terms of its awareness of collaborative capacities to tackle environmental risks. This is partly explained by the several agreements struck by Indonesia with other development partners such as the World Bank and the EU.[84] For instance, the Indonesian government will benefit from USD 110 million in funding from the World Bank's Forest Carbon Partnership Facility to fight biodiversity loss and climate change by preserving forests from further degradation and/or destruction.[85]

Despite the country scoring low in terms of awareness of collaborative capacities to tackle environmental risks, Saudi Arabia has not been inactive in this regard. The G20 Riyadh summit 2020,[86] with the slogan "Safeguarding the Planet", sparked online activity in the country with regard to environmental risks. During this summit, the Saudi Deputy Minister for Environment, Dr. Osama Faqeeha, underlined the importance of strengthening cooperation to reduce land degradation and habitat loss, and promote coral reef conservation, stressing that the "Saudi presidency is pursuing collective efforts and taking concrete actions to safeguard the planet".[87]

C. Collaborative capacities relating to technological risks

Figure 3.14: Countries' awareness of collaborative capacities relating to technological risks

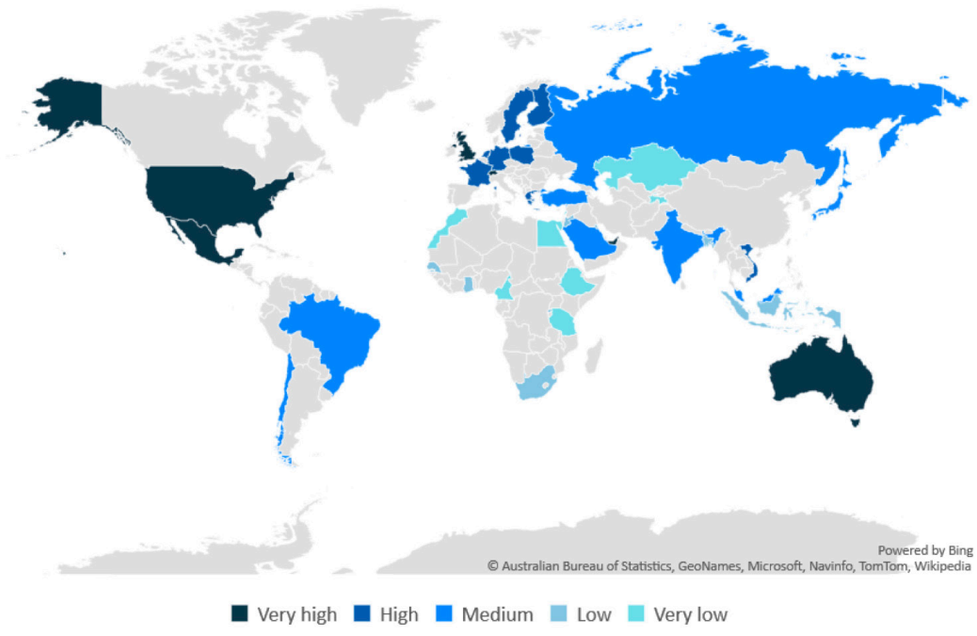


Table 3.5: Countries' awareness of collaborative capacities relating to technological risks

Country	Mentions	Engagement	Awareness Index	Awareness Level
Mexico	17,033	2,618,753	53.11	Very high
Luxembourg	1,743	6,159	51.12	Very high
Switzerland	21,225	64,752	45.58	Very high
United States	686,400	7,378,700	43.34	Very high
Singapore	11,228	86,696	39.05	Very high
United Kingdom	110,907	3,051,100	37.87	Very high
United Arab Emirates	20,975	56,276	37.24	Very high
Australia	29,833	61,007	29.74	Very high
Poland	43,469	85,309	24.56	High
Germany	98,040	240,447	23.12	High
France	60,787	760,093	22.82	High
Greece	6,796	28,320	15.68	High
Netherlands	10,836	29,045	12.20	High
Finland	2,845	21,722	12.03	High
Viet Nam	32,627	365,927	11.82	High
Sweden	6,297	13,272	11.68	High
Turkey	39,900	136,280	11.25	Medium
Brazil	39,453	788,567	10.64	Medium
Chile	4,870	49,157	9.91	Medium
Saudi Arabia	17,348	28,927	9.33	Medium
Japan	41,827	298,307	8.19	Medium
India	90,913	614,447	7.71	Medium
Russian Federation	34,373	236,053	6.91	Medium
Malaysia	5,682	50,852	6.35	Medium
South Africa	5,463	52,122	5.85	Low
Jordan	2,152	1,126	5.59	Low
Senegal	1,353	1,112	5.13	Low
Ghana	1,378	10,479	4.45	Low
Indonesia	21,687	97,220	4.16	Low
Kuwait	634	229	2.54	Low
Rwanda	184	835	2.54	Low
Bangladesh	1,473	6,156	2.41	Low
Egypt	8,071	1,700	2.31	Very low
Lebanon	549	1,059	2.24	Very low
Morocco	1,870	6,342	2.14	Very low
Kazakhstan	753	905	1.10	Very low
Tanzania (United Republic of)	335	535	1.04	Very low
Ethiopia	117	348	0.94	Very low
Cameroon	233	262	0.93	Very low
Tajikistan	93	8	0.70	Very low

Note: Mentions and engagements are reported in absolute terms. In order to calculate the Awareness Index, we used a formula in which the two composites (mentions and engagement) were first standardized, then normalized and finally linearly combined. Please refer to Chapter 2—Methodology for more information about how the Awareness Index and awareness category level are calculated.

The analysis shows that awareness of collaborative capacities related to technological risks is particularly high in Singapore. The advanced results associated with technological risks also relate to collaboration between the private and public sectors. In mid-2020, Huawei announced the launch of Cyber Range courses to provide SMEs and partners with essential cybersecurity capabilities, following the launch of its new virtual AI academy to accelerate the training of ICT professionals.[88]

Throughout the observed period, online activity was also sparked by several news reports related to AI, its associated risks and collaboration initiatives that generated a high level of interest among the online and social media community. In this context, in April 2019 Singapore's numerous initiatives concerning AI Governance and Ethics were recognized at the Annual World Summit on the Information Society through its receipt of the top award in the Ethical Dimensions of the Information Society category.[89] Furthermore, in November 2019, Singapore launched its National AI Strategy. In this context, through which the country will focus on driving the deployment of AI in nine key sectors of high social and economic value for the country, including cybersecurity, as AI is seen as a key technology to address cybersecurity threats.[90] The strategy identifies several key enablers for AI innovation and adoption, including the strengthening of "partnerships and capabilities between the research community, industry and Government to speed up the deployment and commercialisation of AI solutions".[91] In light of the risks AI can generate—such as privacy violations or deep fakes —special emphasis is also placed on the country's strategy for the ethical use of AI, where Singapore's balanced approach has drawn international attention.

Throughout the study period, Switzerland also ranked among the top performers in terms of awareness of collaborative capacities with regard to addressing technological risks. Online activity was notably driven by the new challenges posed by the COVID-19 pandemic concerning data privacy generated by the contact tracing app, jointly developed by teams at ETH Zurich and EPF Lausanne on behalf of the federal government.[92] To address the risks relating to data privacy, the source code of the contact tracing app was released for public testing, therefore calling on civil society to collaborate to ensure its safety. Reports were subsequently sent by the public to the National Cybersecurity Centre for review in order to identify changes to the app based on the problems detected.[93,94] Other peaks of engagement reflected the decision by Facebook to establish the Libra Association (now Diem Association) in Geneva, a subsidiary responsible for its development of the blockchain-based cryptocurrency.[95] Libra is built on open-source code that allows the developer and research community to monitor it for design and security flaws, thus ensuring improvements over time and guaranteeing instantaneous, low-cost, highly secure transactions.[96] In doing so, it addresses the issue of potential cyberattacks (including malware, phishing, ransomware) and fostering financial inclusion.[97]

Other countries exhibited very high levels of awareness of collaborative capacities related to technological risks. This is the case for Mexico, which, in the context of its new trade agreement with the United States and Canada, will leverage cooperation with its trade partners to fight cyberattacks affecting e-commerce activities.[98] This is particularly important in the context of a number of cyberattacks affecting companies and government institutions in Mexico.[99] In addition, three Mexican companies received funding from the Organization of American States, Cisco, and Citi Foundation through the Cybersecurity Innovation Fund, for solutions aiming to solve various cybersecurity challenges in the areas of education, capacity building, cybersecurity for SMEs, critical infrastructure, incident response mechanisms and digital crimes.[100] This includes a tool designed for government entities for the identification, classification and management of sensitive data obtained publicly.[101]

3.2.1.3 Conclusion

Collaborative capacities account for 15.12 percent of the share of mentions across all risks, which is slightly above the 12.06 percent share observed for innovative capacities. This suggests that, even if by a small margin, collaborative capacities are seen as more significant than innovative capacities in leveraging knowledge and future skills to address future risks. However, countries' awareness of collaborative capacities to address future disruptions remains limited in light of the awareness of all risks, irrespective of capacities.

Mentions of collaborative capacities remained globally stable for the entire period studied, especially for both technology (+1.8 percent) and health risks (-1.05 percent), while a rising trend can be observed for environmental risks (+3.9 percent). Concerning health risks, the decrease can be explained by an explosion of COVID-related news during this period, which was not accompanied proportionally by collaboration-related news. At the same time, it should be noted that collaborative capacities have grown particularly in terms of their share of mentions after the first wave of COVID-19—suggesting that collaboration is seen as a significant means of leveraging knowledge dimensions and future skills to address health risks. While countries recognized the power of collaborative capacities in addressing risks and building forward better amid the pandemic, it is worth noting that countries should also strengthen their collaboration in times of prosperity.

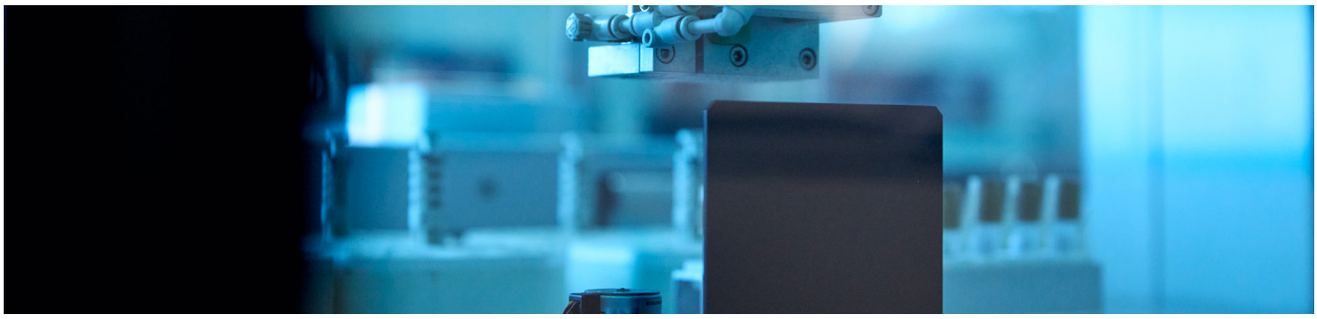
The enabling environment is the knowledge dimension where there is the most significant share of mentions on collaborative capacities when it comes to environmental and health risks, accounting for 58.57 percent and 38.56 percent of mentions, respectively. Significant awareness under the enabling environment dimension was generated for both risks by the various high-level events and conferences organized among global leaders, as well as political events (such as the G20) to address the pressing issues of climate change (environmental risks) and of the COVID-19 crisis (health risks). With regard to technological risks, the economy gathered most of the mentions (28.89 percent), which can be explained by government measures encouraging digitalization as a mean to support businesses in managing the COVID-19 crisis and ensuring the delivery of education.

Among the countries studied, Australia, Mexico, Switzerland, the United Kingdom and the United States, demonstrate a high level of awareness related to collaborative capacities for the three risks analysed. This suggests that collaboration is perceived in these countries as pivotal to leveraging knowledge and future skills to address risks. In practice, this means that they are ready to leverage partnerships and cooperation within their countries but also with other countries (whether at the regional or global level) in order to address environmental, technological or health risks. On the other side of the spectrum, countries such as Cameroon, Ethiopia, Kazakhstan, Tajikistan and the United Republic of Tanzania appear to have more limited awareness of collaborative capacities to leverage knowledge and future skills to address future risks. This makes these countries vulnerable to future risks, which could cause major disruptions, and potentially hamper economic and social systems.

As mentioned in the introduction to this report, environmental, health and technological risks have different impacts on various countries depending on their specific characteristics. For instance, climate change—though partly driven by the emissions in high-income countries—has greater impacts and costs for developing countries, which often have fewer resources to deal with its effects. Hence, collaboration is key for them in addressing related risks. At the same time, national interests and preoccupations often take precedence, which sometimes makes it difficult for states to trust each other and cooperate. In the case of environmental risks, disparities between countries in terms of development constitute a challenge to effective cooperation as they raise questions as to whether there is a need to differentiate obligations according to development levels.

When it comes to technological risks, it is essential to address the issue of the digital divide and avoid concentrations of digital power to ensure countries can properly cooperate to tackle those risks and therefore take full advantage of the opportunities these technologies offer.

To address health risks, cooperation is essential through different layers of society (education systems, medical systems, businesses, etc.), notably to ensure the early diagnosis, detection and control of underlying risk factors, such as tobacco use, unhealthy diets, physical inactivity and harmful use of alcohol. It is therefore vital to address the various challenges to cooperation to ensure that it can remain a key means for addressing risks to sustainable development.



3.2.2 INNOVATIVE CAPACITIES

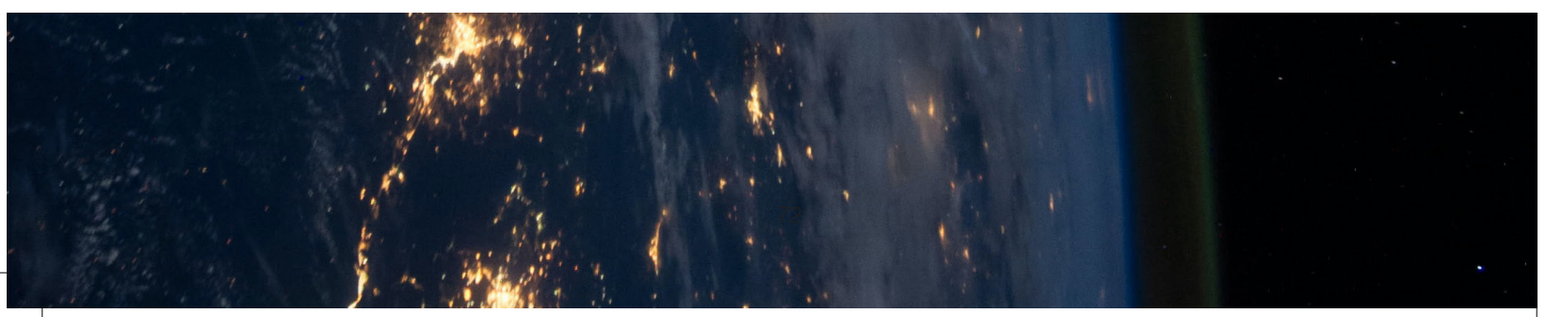
While innovative capacities could be defined as continually improving capabilities, complemented by the creation and localization of knowledge to discover new opportunities whilst adapting and transforming to negate major risks,[102] empirical research has also shown the existence of a positive correlation between innovation and future performance.[103] Innovative capacities are considered essential in order to drive sustainable solutions that address pressing current and future challenges. The objective of this section is to understand, at the global level, countries' awareness regarding the role of innovative capacities in developing robust and viable knowledge dimensions and future skills to respond to health, environmental and technological risks.

Innovative capacities to address health risks have long been viewed as important. Some of the recent applications of the latest developments in responding to the COVID-19 pandemic are particularly noteworthy. COVID vaccines have been developed faster than any others in the past, thus changing the future of vaccine development. Previously, the quickest vaccine to be developed was for mumps in the 1960s, which took four years from virus sampling to licensing.[104] The speed of development of COVID-19 vaccines was made possible by previous research on related viruses, significant investment in production capacities, and the ability of regulators to quickly adapt existing regulations.

Innovative capacities are also key to addressing environmental risks. As underlined by SDG 9, developing innovative greener infrastructures, upgrading and redesigning existing infrastructure systems, and building upon smart technology's potential can all help to reduce the environmental impact of human activities.[105] In this regard, in Rwanda, the government established in 2019 the Cleaner Production and Climate Innovation Center (CPCIC), which supports green innovation by offering Rwandans (in both the public and commercial sectors) training in clean manufacturing and climate-resilient technology.[106] In the context of the European Green Deal, the European Union launched in October 2020 a EUR 1 billion call under Horizon 2020 aimed at funding research and innovation projects that will contribute to the EU's response to climate change and support the protection of Europe's ecosystems and biodiversity.[107]

Countries' innovative capacities also play a significant role when tackling technological risks. Due to the unexpected magnitude of the COVID-19 crisis, governments were forced to rapidly pivot to digital tools and environments in order to ensure the continuity of their activities and propose solutions to the pandemic.[108] In light of this increased reliance on the digital environment, cybersecurity is of the utmost interest. AI is seen as a key technology in addressing cybersecurity threats thanks to its capacity to analyse massive quantities of data at incredible speeds. AI can, therefore, detect risks or even predict them before they occur in real time.[109] Given the vast opportunities it represents, 63 percent of cybersecurity firms were planning to deploy AI in their solutions by the end of 2020.[110] In April 2021, the European Commission put forward a legal framework together with a new Coordinated Plan on AI with Member States, aiming to guarantee the respect of fundamental rights and the safety of its citizens while encouraging AI uptake and innovation.[111] *Inter alia,* this plan addresses the need to build upon the tremendous potential of AI in addressing cybersecurity challenges.

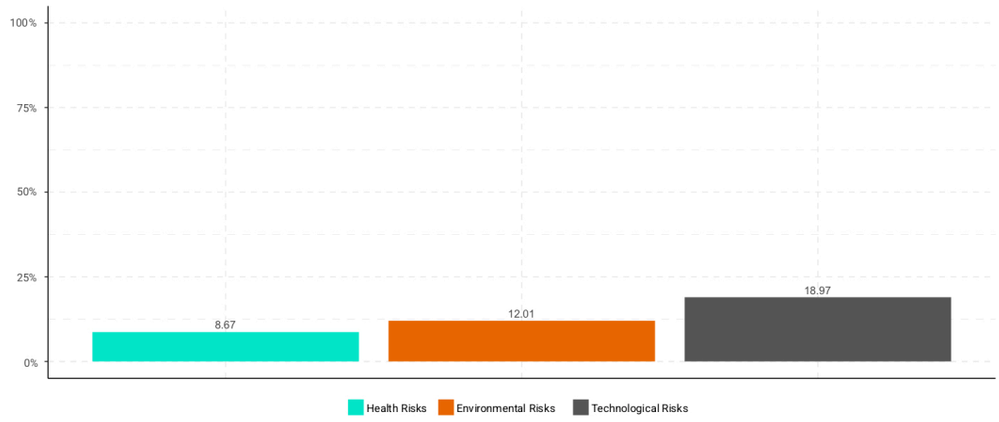
This section further explores the evolution of the awareness of innovative capacities in addressing health, environmental and technological risks between June 2019 and May 2021. The following section provides: i) an overview of the level of awareness of the innovative capacities for addressing each risk in connection with knowledge dimensions and future skills; and ii) an in-depth analysis of the knowledge dimensions and future skills for which innovative capacities are perceived as most important.



3.2.2.1 Global trends in leveraging innovative capacities to respond to risks

The analysis of online media activity reveals that between June 2019 and May 2021 (the period for which data has been extracted), there was limited global awareness of the importance of innovative capacities in addressing future risks (with less than 20 percent of global mentions relating to innovative capacities). Figure 3.15 reveals that 18.97 percent of the total mentions concerning technological risks were related to innovative capacities. The results are slightly different for environmental and health risks, which feature about half as many mentions—12.01 percent and 8.67 percent, respectively, of the total mentions relating to innovative capacities. Figure 3.15 suggests that innovative capacities are perceived as particularly relevant in leveraging knowledge dimensions and future skills to tackle technological risks. Conversely, countries seem to be less prepared to mobilize their innovative capacities to tackle health and environmental risks. This is partly due to the differing nature of each of these risks.

Figure 3.15: Global share of mentions related to innovative capacities by risks

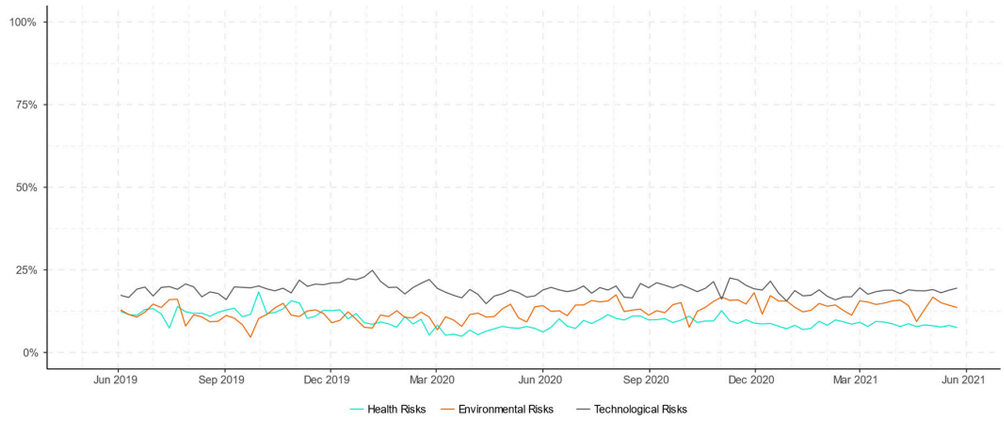


When analysing the fluctuations of mentions over time, as shown in Figure 3.16, awareness of innovative capacities in tackling technological risks increased slightly from 3 June 2019 to 30 May 2021, from 17.3 percent to 19.5 percent. The highest levels of awareness in relation to technological risks were observed in January 2020, when Singapore launched new AI initiatives at the World Economic Forum to fight potential misuse and/or unethical use of AI, enhance consumer trust, support innovation and act as a reference point in AI.[112,113]

Among those initiatives, the 'Model AI Governance Framework' setting out high-level ethical principles for the implementation of AI has been refined in a second edition. "The Model Framework has seen take-up and alignment from over fifteen organizations of all sizes internationally – from financial giants such as DBS, HSBC, Mastercard and Visa, fintech firms such as Suade Labs, to technology firms such as pymetrics, UCARE.AI and a school, Ngee Ann Polytechnic".[114] At a time when common global standards with regards to AI are emerging, Singapore not only contributes to developing awareness of the necessity of promoting the ethical use of AI, but also provides a model for others in addressing the risks that this technology could generate.[115]

While the evolution of the degree of awareness of innovative capacities in tackling environmental and health risks was mostly stable over the period, it is worth mentioning the slight decrease in the level of awareness of innovative capacities in addressing health risks starting in 2020. This can be explained by the fact that the analysis employs the ratio of the total number of mentions relating to health risks to content regarding innovative capacities related to health risks. The quantity of online content relating to health risks drastically increased with the start of the COVID-19 pandemic. The share of mentions relating to innovative capacities decreased in relation to total mentions, even though the quantity increased in absolute terms.

Figure 3.16: Global share of mentions related to innovative capacities by risk over time



The analysis of the themes that appear in content relating to technological risks reveals that significant global interest was generated around AI and blockchain. With the rise of the use of AI, questions are emerging related to the ethical use of the technology.[116] Similarly, access to 5G networks offers new opportunities. For instance, it is expected to lead to significant increases in the volume of data transferred, Internet of Things (IoT) connections, and more generally to the potential for innovation enabled by this technology. At the same time, this may in turn increase the potential for cyberattacks against which companies and organizations require protection. Hence, businesses and governments are actively improving their cybersecurity.[117]

The rise of mentions for innovative capacities in relation to technological risks was linked to significant interest and awareness around the use of blockchain, investments in cryptocurrencies and related regulations.[118,119,120,121] For example, discussions generally referred to exchanges of cryptocurrencies through platforms that act as banks but are not subject to the same regulations.[122] Other discussions on digital currencies related to their adoption by governments, where significant differences in approaches are observed. Some countries are more cautious in their integration of cryptocurrencies, while others already rely on them to expand local economies.

Throughout the period of analysis, the global share of mentions related to innovative capacities for environmental risks remained generally stable. Fluctuations in the number of mentions were nevertheless driven by three major events that generated a considerable volume of online discussions. The peak number of mentions around September 2019 may be explained by the UN Climate Action Summit organized in New York in the same period. The objective of the Summit was for countries to present concrete and realistic national plans to reduce greenhouse gas emissions by 45 percent over the next decade and to reach a zero-emission target by 2050. Following the meeting, all countries committed to presenting even more ambitious national climate plans aligned with these two objectives in 2020. In Spain, for example, the requirements for further research, innovation and competitiveness form a strong component of the Integrated National Energy and Climate Plan 2021–2030, highlighting the need for innovation in sectors such as solar and wind power, and energy efficiency in order to address climate change.[123]

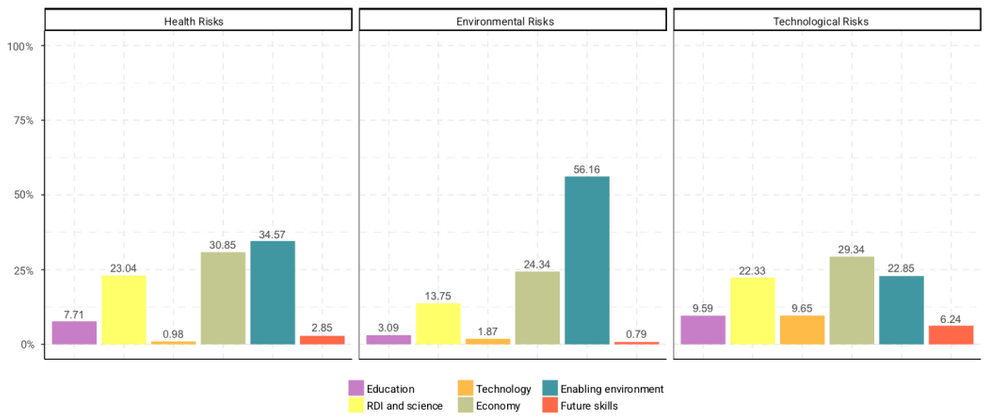
A second peak in mentions occurred in December 2020 in connection with the Climate Ambition Summit, co-hosted by the United Nations, the United Kingdom and France, in partnership with Chile and Italy, which brought together over 100 influential leaders from across the globe. The objective of the Summit was to set out new and ambitious goals for countries in the fight against climate change under the three pillars of the Paris Agreement (mitigation, adaptation and finance commitments).[124] Moreover, this Summit provided an opportunity for countries, organizations and companies to demonstrate their efforts, initiatives and goals in fighting climate change. Among other examples, Godrej & Boyce, an Indian manufacturing company, announced its commitment to key global initiatives by setting science-based targets and promoting energy efficiency through the EP100 energy smart business initiative in order to achieve carbon neutrality by 2050.[125] The aim is to achieve this by promoting innovation and adopting new technologies that are increasingly energy-efficient.[126]

A third peak occurred in April 2021, coinciding with the Leaders' Summit on Climate organized by the Biden Administration. The summit covered a broad range of topics, such as critical discussions about developing innovative methods for countries and regions to address climate change. These included, for instance, potential innovative solutions focusing on water and coastal management, or the need for better technology to meet fast-evolving agricultural challenges.[127]

Unsurprisingly, a rise in the total number of mentions related to health risks was observed around March 2020, when the WHO declared the COVID-19 crisis a pandemic, with multiple mentions relating to research on vaccines and treatments.[128] Relevant articles referred to the race for innovation in vaccine development between countries, as well as the multi-billion dollar industry that lies behind COVID-19 vaccine research.[129] While the absolute number of mentions relating to health risks peaked in 2020, the share of innovation mentions returned to its original trend and displayed an overall negative trajectory over the period of analysis. This can be explained by the vast increase in day-to-day news regarding the COVID-19 pandemic in this period, which saturated the total count of health-related mentions, with innovation related news being limited to the development of the vaccine and the booster.

The remaining part of this section delves into the analysis of the data by providing insights on the individual knowledge dimensions and future skills for which innovative capacities are perceived to play an important role.

Figure 3.17: Distribution of mentions of innovative capacities by risk across knowledge dimensions and future skills



Significant disparities among the different knowledge dimensions and future skills are observed across the three risks. When looking at environmental risks, enabling environment and economy were the knowledge dimensions most discussed (in terms of number of mentions) in relation to innovation. Together, they accounted for more than 80 percent of the mentions related to innovation in environmental risks, generating 56.16 percent and 24.34 percent of mentions, respectively. The analysis of online activity relating to innovation mentions in the context of environmental risks reveals that a significant number of enabling environment mentions related to innovative environmental laws and policies implemented by countries over the period. One such example is the European Green Deal, the aims of which are to reduce greenhouse gas emissions in the EU to at least 55 percent below 1990 levels by 2030[130] by investing in a green transition that "will modernize our economy, make it more innovative, circular and resilient and sustain its global competitiveness and prosperity in the years to come."[131] Another example is the online activity generated by the reintroduction of the Green New Deal bills in the United States in April 2021.[132] The Green New Deal is primarily focused on fighting climate change, but also includes wide-ranging social and economic reforms that will require emphasis on innovative digital technologies as a means to combat climate change in the years to come.[133]

The distribution of mentions of innovative capacities relating to health risks is dominated by mentions of the enabling environment (34.57 percent of innovation-related health risks mentions) and the economy (30.85 percent). This highlights the importance of regulations, and access to finance and investments, in addressing health risks through innovation. Unsurprisingly, the analysis of the health innovation related online activity mostly refers to COVID-19 vaccine research.[134] It also touches upon the various innovative solutions that were

implemented by private companies in response to the pandemic, such as transforming plants into facilities for the production of masks[135] or hydroalcoholic gels.[136]

The economy appears to be the dimension that generated most of the mentions on innovation to face technological risks (29.34 percent of the innovation-related mentions), closely followed by enabling environment, RDI and science (22.85 percent and 22.33 percent, respectively). The analysis of technology–economy related mentions indicates a significant amount of discussion around the importance of venture capital funding for cybersecurity companies. According to a report from the business information platform, Crunchbase,[137] 2020 was a record year for cybersecurity investments, despite the COVID-19 pandemic. With over $7.8 billion invested in the industry globally (a more than nine-fold increase since 2011), the United States led cybersecurity funding in 2020 by contributing $5.9 billion, representing an increase of 22 percent over the previous year.[138] This increased investment in cybersecurity can be explained by the massive, forced transition to remote working due to the pandemic. This transition increased the volumes of data and sensitive documents being transferred through cloud services and therefore heightened the need for security against hackers and data breaches. Additional mentions refer to the increasing use of AI technologies, and their associated risks, within financial institutions. The mentions reflect the limited awareness of financial institutions regarding the potential disruptions of this technology and the necessity of better preparedness to address and mitigate such risks.[139]

Box 3.2: Focus on innovative capacities and future skills

In an increasingly digital and perpetually changing world, awareness of future skills in addressing risks appears to be limited despite the importance of supporting the workforce in developing their skills. Indeed, according to the World Economic Forum, 50 percent of all employees will require reskilling by 2025.[1] In addition, analytical thinking and innovation have been identified as the top skills to have in 2025,[2] emphasizing the fact that innovation capacities represent fundamental elements for national skills development strategies. There is therefore a strong need for coordination between the private sector and governments to develop relevant national strategies that can equip their societies with essential future skills.

In order for economies to fully recover from the pandemic, countries will need to reskill employees, especially those who have lost employment and have had to adapt to the 'new normal'. Governments must implement innovative policies to make efficient use of people's skills in a way that supports their countries' abilities to adapt and transform in order to address future risks. The analysis of online activity reveals that some countries have started developing and implementing national skills strategies to respond to future health, environmental and technology risks. Country-specific examples are presented below.

In the United Kingdom, and more specifically in Scotland, the Low Carbon Innovation Transition Programme (LCITP) for Heat and Industry (a Strategic Intervention supported by the European Structural and Investment Funds),[3] supported the company, Graham's, a family dairy company, in developing an innovative low carbon heat project for one of their plants. The envisioned facility will produce and distribute biofuels for onsite heat and electricity generation, being the first of its kind in Scotland's dairy industry. These ground-breaking initiatives are proposed alongside a skills development programme aimed at upskilling and reskilling workers in the dairy sector. The training was provided to support the clean growth agenda of the company and therefore contributed to its environmental objectives. Such initiatives represent critical innovation that contributes towards building zero carbon industries and encompasses infrastructure and skills development to accelerate climate adaptation within industry. Overall, such initiatives are responses to climate change and environmental risks.[4,5]

In September 2020, the South African Ministry of Communications and Digital Technologies published the National Digital and Future Skills Strategy. This strategy defines mechanisms to enhance digital skills development in the country from early childhood development all the way to various post-school training levels. This represents a strong acknowledgment that skills are indispensable for sustainable economic growth across all sectors and are required to equip societies with the right resources for future digital developments and innovations to tackle health, environmental and technology risks. Moreover, with the rise of new technologies, South Africa has also defined cybersecurity as a strategic pillar of its national strategy to confront potential technological risks. Skills development will be set up through open online courses, game-based and virtual reality learning, and other online learning modalities delivered via digital learning platforms. To support and monitor this strategy, the Ministry created a five-year comprehensive Digital and Future Skills Implementation plan, which will be revised and updated every five years after a formal public consultation.[6]

In Finland, a commitment in December 2019 to train one percent of EU citizens in the fundamentals of AI to bolster the EU's digital leadership generated significant online activity. Finland has been a pioneer in the field of AI over the past several years. To support the government of Finland's ambitious national AI strategy, the University of Helsinki collaborated with the private sector company Reaktor Education[7] to develop and launch Elements of AI[8] in 2018. This provides a free, open online class devoted to AI concepts, their societal implications and the development of AI systems. One of the main objectives of the initiative is to enable participants to be empowered rather than threatened-

by AI and help them to understand how AI could help societies solve potential problems in the future. Elements of AI, unlike most AI courses, is designed to be widely accessible and requires no prior technical knowledge. When the initiative was first announced, it set a goal of training one percent of Finland's population. Having achieved its goal, the country extended it to the EU during its EU Presidency, offering the online course to all Member States for free.[9]

All of these initiatives to upskill and prepare the workforce for the future of work contribute to making countries more agile in the face of future health, environmental and technological risks, increasing their capacities to learn, adjust and transform, and thus mitigating potential negative effects such as a discontinuation of government services.

Notes: **1.** WEF, 2020b; **2.** Ibid.; **3.** See Scotland, Energy and Climate Change Directorate, n.d.; **4.** Stark, 2020; **5.** Bioenergy Insight, 2020; **6.** See South Africa, Department of Communications and Digital Technologies, 2020; **7.** See Reaktor, n.d.; **8.** See https://course.elementsofai.com/; **9.** OPSI and MBRCGI, 2020.

3.2.2.2 Country-level trends in leveraging innovative capacities to tackle risks

Given the importance of analysing trends concerning innovative capacities for each of the risks at the country-level, Figure 3.18 and Table 3.6 show the most discussed risks in terms of number of mentions (health, environmental or technological) relating to innovative capacities by country.

Figure 3.18: Most discussed risks relating to innovative capacities

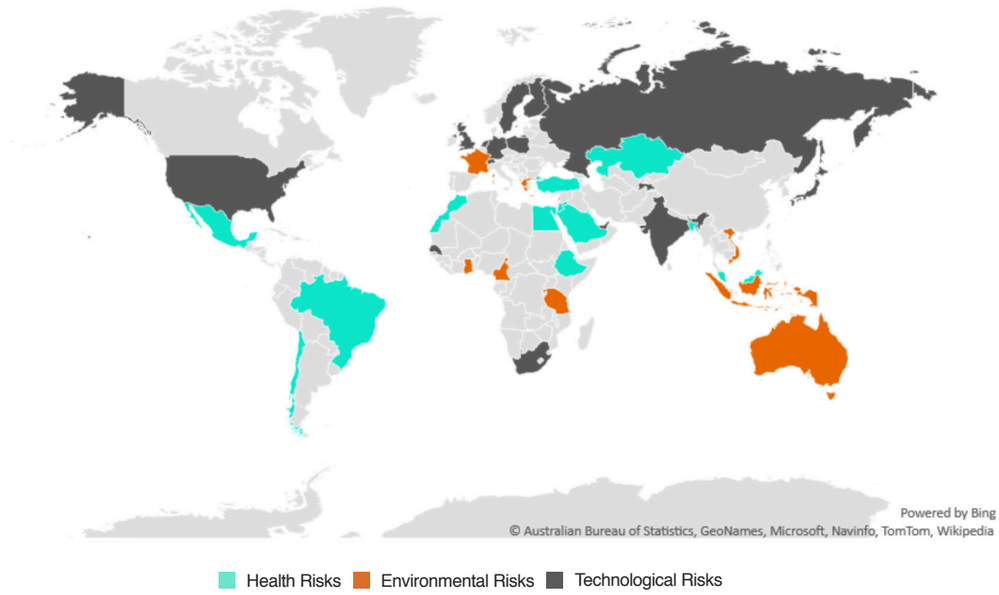


Table 3.6: Most discussed risks relating to innovative capacities by country

Health		Environmental	Technological	
Bangladesh	Mexico	Australia	Finland	Senegal
Brazil	Morocco	Cameroon	Germany	Singapore
Chile	Saudi Arabia	France	India	South Africa
Egypt	Turkey	Ghana	Japan	Sweden
Ethiopia		Greece	Lebanon	Switzerland
Jordan		Indonesia	Luxembourg	Tajikistan
Kazakhstan		Rwanda	Netherlands	United Arab Emirates
Kuwait		Tanzania (United Republic of)	Poland	United Kingdom
Malaysia		Viet Nam	Russian Federation	Unites States

Note: The analysis illustrated in Figure 3.18 and Table 3.6 is based on the number of mentions (relating to a specific risk and innovative capacity) relative to total number of mentions (relating to a specific risk) within the given country.

As shown in Figure 3.18 and Table 3.6, innovative capacities were identified as the most relevant means to address technological risks in almost half of the countries studied (18) between June 2019 and May 2021. In the Netherlands, for instance, the launch of the Strategic Action Plan for Artificial Intelligence generated a considerable number of innovation-related mentions, as the plan notably promotes research into the use of new technologies in various fields such as education, digital infrastructure and digital transformation—including AI—for cyber resilience.[140]

Online activity was also sparked in the country by the announcement of the allocation of funds to different projects designed to boost research and innovation. Among these, Quantum Delta Netherlands has been awarded €615 million from the National Growth Fund. The organization represents a large coalition of Dutch companies, universities and other knowledge institutions that aims to establish the requisite infrastructure for quantum technology, as well as its development and practical applicability, especially in relation to dealing with technological risks. Through the development of the first quantum computer, the first large quantum network and quantum sensors, the network notably aims to contribute to cybersecurity through the development of a secure (quantum) Internet.[141]

For 13 of the countries studied, a higher level of awareness of the role of innovative capacities in addressing health risks was seen. In Mexico, for instance, health risks are the most discussed risks in relation to innovative capacities. This relates in part to the activities organized by a Mexican public university, the Autonomous University of Queretaro, to raise funds to develop the country's own COVID-19 vaccine by the end of 2021.[142,143]

In the remaining nine countries, innovative capacities are considered most relevant in tackling environmental risks. For example, in Ghana, where environmental risks are the most discussed in relation to innovative capacities, numerous innovation-related mentions were generated around the end of the Africa Netpreneur Prize Initiative (ANPI), organized in the country in October 2019. The prize's goal is to encourage and assist the next generation of innovative African entrepreneurs in creating a more sustainable and inclusive continent. ANPI also actively seeks to address climate change challenges faced by the continent, such as water access and food security.[144]

In terms of the level of engagement[145] (i.e. the awareness in terms of interest) relating to innovative capacities to leverage knowledge dimensions and future skills to address risks, health risks attracted the most engagement in 27 countries, followed by environmental risks (nine countries) and technological risks (four countries) over the study period.

Figure 3.19: Most engaging risks relating to innovative capacities per country

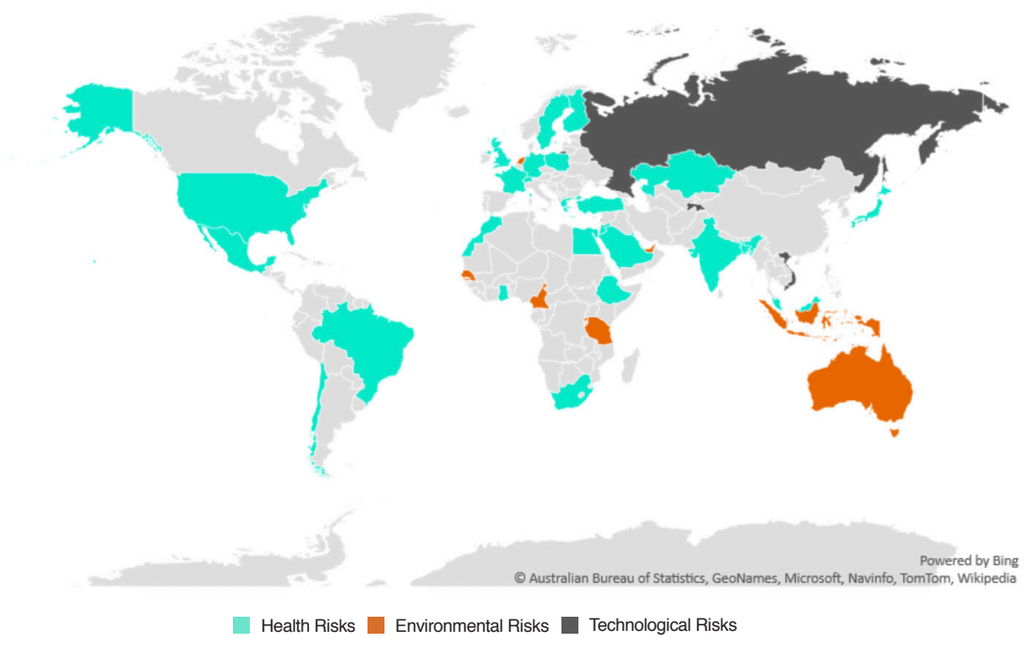


Table 3.7: Most engaging risks relating to innovative capacities per country

Health		Environmental	Technological
Bangladesh	Kazakhstan	Australia	Lebanon
Brazil	Kuwait	Cameroon	Russian Federation
Cameroon	Malaysia	Indonesia	Tajikistan
Chile	Mexico	Luxembourg	Viet Nam
Egypt	Morocco	Netherlands	
Ethiopia	Poland	Rwanda	
Finland	Saudi Arabia	Senegal	
France	Singapore	Tanzania (United Republic of)	
Germany	South Africa	United Arab Emirates	
Ghana	Sweden		
Greece	Switzerland		
India	Turkey		
Japan	United Kingdom		
Jordan	United States		

Note: The analysis illustrated in Figure 3.9 and Table 3.7 is based on the number of engagements.

These engagement-related results are not surprising, being largely driven by major events that took place between 2019 and 2021, in particular the advent of the COVID-19 pandemic. In this context, the capacity to innovate and create knowledge to mitigate the health impacts of COVID-19 received the most interest from the online and social media community. For instance, one of the most engaging news stories in South Africa over the period related to the creation of an oxygen delivery device to keep COVID-19 patients' lungs from collapsing. This innovative product partly addressed the issue of limited capacity in hospitals, intensive care units and other high care facilities. Beyond alleviating the risk to life in South Africa, the oxygen delivery device has also been distributed to other countries including the Central African Republic, the Democratic Republic of the Congo and Zimbabwe.[146]

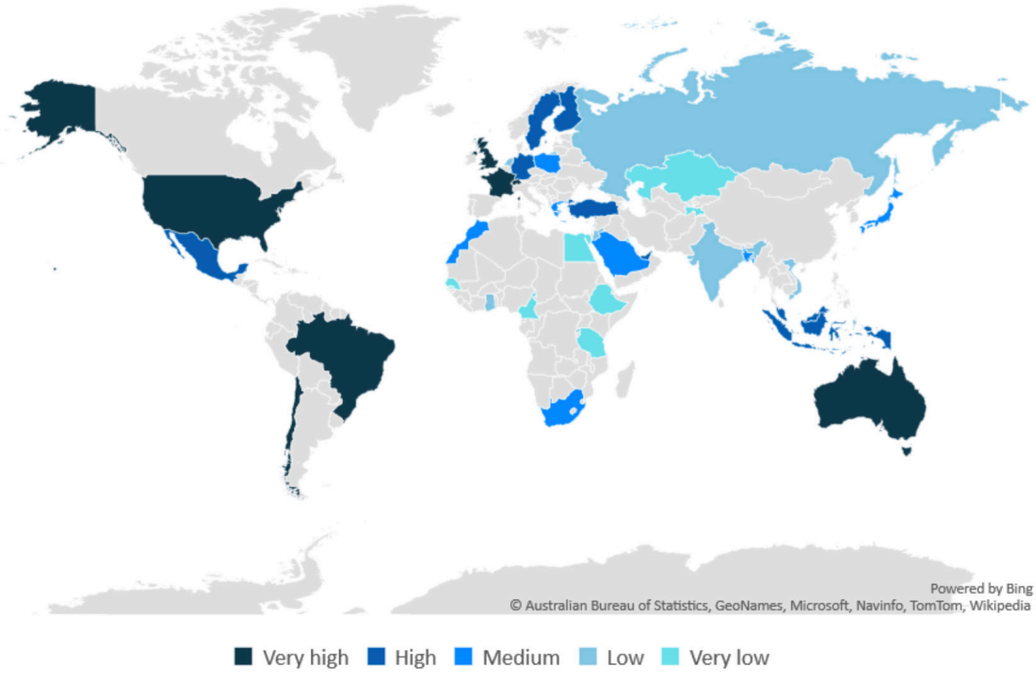
In terms of innovative capacities to tackle environmental risks, several innovations have been developed, including in the fields of circular economy and renewable energy. In Cameroon, for instance, two peaks of engagement were observed. The first relates to the investment supported by the United States Trade and Development Agency (USTDA) for the deployment of renewable energy in rural areas in the country, which aims to connect around 100,000 households to mini electricity networks[147] and contribute to inclusive and sustainable development. The second peak was driven by a private sector initiative by the brewery, Brasaf, to offer PET plastic beer bottles, with a view to limiting waste through a circular economy model.[148] These bottles can be recycled by the company itself, which has invested in a recycling plant for this purpose.

Finally, some of the most engaging news relating to innovative capacities employed in addressing technological risks concerned the prevention of cyberattacks and their impacts on government. For example, Viet Nam is actively seeking innovative solutions to defend against cyberattacks, which are considered a major threat to the economy and national security. In this context, the Viettel AI Open Platform, developed by the military-run telecoms group Viettel, was launched by the Ministry of Information and Communications in Vietnam. Part of a series of initiatives to introduce made-in-Viet Nam digital platforms, Viettel aims to strengthen research cooperation and boost the national digital transformation programme, which placed notable emphasis on cybersecurity.[149]

The remaining figures and analysis presented in this section provide a complete overview and comparison of countries' innovative capacities for each of the risks in connection with knowledge dimensions and future skills.

A. Innovative capacities relating to health risks

Figure 3.20: Countries' awareness of innovative capacities relating to health risks



In the United Kingdom, the announcement by the government of the creation of new digital innovation hubs drove significant online media activity. The digital innovation hubs aim to ease access for innovators to data from the National Health Service (NHS)—therefore facilitating the identification of revealing data trends which may help with finding cures or treatments—to research the factors behind many familiar common diseases and to deliver more efficient clinical trials. "The £37.5 million investment in Digital Innovation Hubs is a key part of the modern Industrial Strategy, and its Data to Early Diagnosis and Precision Medicine Challenge".[150] In Singapore, mentions refer to the digital hackathon organized by Razer Fintech[151] in May 2020 to address banking challenges exacerbated by the COVID-19 pandemic. Prizes were offered to enable participants to implement and operationalize innovative banking solutions for Razer Fintech's financial services or with its partners.[152]

Brazil also ranked among the top performers in terms of the degree of awareness of the role of innovative capacities in leveraging knowledge and future skills to address health risks. This was driven by science, technology and innovation institutions, and the key role they played in funding academic research, start-ups and public–private partnerships.[153] This led directly to the development by the University of Sao Paulo of an affordable conventional respirator[154] and an AI solution to help doctors diagnose COVID-19.[155]

Table 3.8: Countries' awareness of innovative capacities relating to health risks

Country	Mentions	Engagement	Awareness Index	Awareness Level
United Kingdom	157,467	10,224,220	82.86	Very high
United States	832,360	36,882,780	72.77	Very high
Brazil	73,027	4,737,847	56.12	Very high
Switzerland	29,739	141,197	53.63	Very high
Australia	44,507	590,647	44.93	Very high
Singapore	9,736	166,919	38.48	Very high
Chile	12,586	394,412	37.93	Very high
France	60,513	1,741,353	37.04	Very high
United Arab Emirates	23,786	125,493	37.02	High
Mexico	47,047	1,809,687	36.56	High
Malaysia	6,733	260,189	32.97	High
Sweden	6,105	153,335	27.80	High
Finland	1,843	53,762	27.31	High
Indonesia	50,500	1,359,920	25.85	High
Germany	94,847	923,453	24.71	High
Turkey	101,453	417,440	23.89	High
South Africa	9,035	221,856	22.54	Medium
Morocco	4,954	130,018	22.50	Medium
Luxembourg	796	2,784	20.83	Medium
Poland	28,864	286,695	20.25	Medium
Greece	9,035	55,109	19.90	Medium
Japan	28,873	488,153	16.16	Medium
Bangladesh	3,735	55,204	13.60	Medium
Saudi Arabia	27,212	80,859	13.30	Medium
India	74,080	925,013	13.12	Low
Netherlands	8,263	43,966	10.91	Low
Ghana	1,965	16,638	8.74	Low
Jordan	3,625	5,388	8.45	Low
Viet Nam	36,640	21,080	7.72	Low
Rwanda	203	1,400	6.18	Low
Lebanon	1,885	2,966	5.80	Low
Russian Federation	22,780	96,107	5.62	Low
Egypt	15,872	20,172	4.52	Very low
Kazakhstan	1,205	5,275	4.26	Very low
Kuwait	996	949	3.76	Very low
Tanzania (United Republic of)	880	2,728	3.56	Very low
Senegal	984	963	3.48	Very low
Ethiopia	232	1,042	3.44	Very low
Cameroon	227	137	0.82	Very low
Tajikistan	94	3	0.49	Very low

Note: Mentions and engagements are reported in absolute terms. In order to calculate the Awareness Index, we used a formula in which the two composites (mentions and engagement) were first standardized, then normalized and finally linearly combined. Please refer to Chapter 2—Methodology for more information about how the Awareness Index and awareness category level are calculated.

B. Innovative capacities relating to environmental risks

Figure 3.21: Countries' awareness of innovative capacities relating to environmental risks

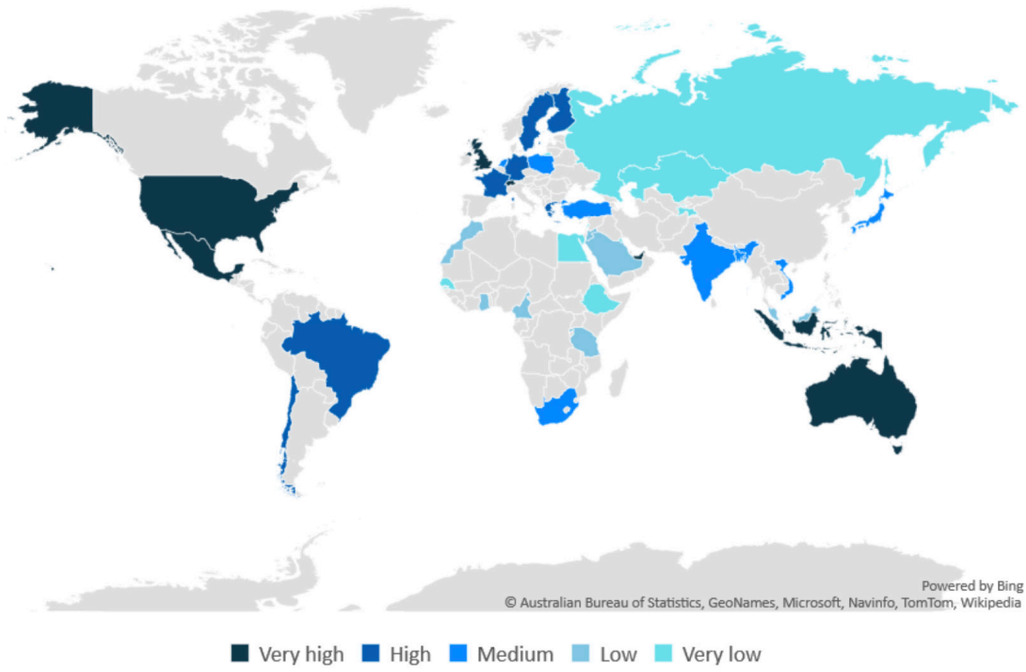


Table 3.9: Countries' awareness of innovative capacities relating to environmental risks

Country	Mentions	Engagement	Awareness Index	Awareness Level
United Kingdom	143,387	8,913,280	79.87	Very high
Indonesia	442,520	7,603,107	59.86	Very high
United States	610,260	23,965,840	59.84	Very high
Australia	53,033	795,767	53.41	Very high
Switzerland	29,774	105,905	52.83	Very high
Luxembourg	1,736	17,012	47.60	Very high
Mexico	20,607	1,131,600	47.12	Very high
United Arab Emirates	19,994	126,838	32.74	Very high
Brazil	40,927	1,489,187	32.64	High
Singapore	7,380	85,003	28.35	High
Germany	135,880	556,407	27.99	High
France	70,200	836,713	26.84	High
Chile	10,053	186,401	25.88	High
Greece	13,348	27,960	24.20	High
Sweden	7,326	100,027	21.15	High
Finland	2,980	41,063	19.01	High
Turkey	77,427	208,067	17.91	Medium
South Africa	8,527	134,312	16.08	Medium
Poland	20,216	106,332	12.99	Medium
Netherlands	9,659	55,327	12.59	Medium

Country	Mentions	Engagement	Awareness Index	Awareness Level
Viet Nam	53,733	20,533	11.05	Medium
Japan	16,813	194,067	11.03	Medium
India	70,953	446,120	8.40	Medium
Bangladesh	3,348	26,135	8.24	Medium
Malaysia	4,019	31,816	8.20	Low
Ghana	2,401	13,182	7.17	Low
Rwanda	254	1,784	6.78	Low
Saudi Arabia	12,851	18,746	6.27	Low
Jordan	2,516	2,154	5.69	Low
Morocco	4,293	13,042	4.39	Low
Cameroon	336	1,387	3.93	Low
Tanzania (United Republic of)	1,684	3,079	3.88	Low
Lebanon	601	1,806	3.75	Very low
Senegal	698	1,143	3.19	Very low
Russian Federation	10,980	27,120	3.03	Very low
Kuwait	476	496	2.18	Very low
Egypt	7,641	2,856	1.91	Very low
Ethiopia	228	421	1.46	Very low
Kazakhstan	687	339	0.82	Very low
Tajikistan	104	4	0.56	Very low

Note: Mentions and engagements are reported in absolute terms. In order to calculate the Awareness Index, we used a formula in which the two composites (mentions and engagement) were first standardized, then normalized and finally linearly combined. Please refer to Chapter 2—Methodology for more information about how the Awareness Index and awareness category level are calculated.

The analysis of capacities related to the knowledge and future skills required to address environmental risks highlights the performance of the United Kingdom and Indonesia, which were among the countries exhibiting the highest levels of awareness of the role of innovative capacities in addressing these risks, with Awareness Index results of around 80 and 60, respectively (Table 3.9).

Growing awareness around environmental risks were noted over the study period in the United Kingdom, which experienced several floods[156,157] and launched preparations for COP26.[158] Several investments were launched by the government to support innovation in tackling environmental risks, including a GBP 134 million investment in cleantech funding as part of the country's green recovery efforts. The funding aims to help "clean growth projects, develop new technologies and secure new jobs".[159] Among other innovations, these investments aim to support new energy projects such as heat networks and integrated energy systems. Other investments include GBP 73.5 million in funding to support innovative low-carbon solutions in the automotive sector (e.g. state-of-the-art integrated high voltage electronics systems, and the development and commercialization of compact zero and low-emission commercial vehicle powertrain solutions or next generation electric vehicle technologies).[160] In parallel, some private sector actors also announced policies and strategies to reduce emissions through innovative low-carbon solutions. For instance, one of the United Kingdom's largest commercial property firms, British Land, announced the establishment of the British Land Transition Fund to accelerate the path to net zero by "driving innovation in development, financing the retrofit of the standing portfolio, and supporting customers in transforming their own space to reduce emissions".[161] The Fund will support the delivery of British Land's sustainability strategy, which will finance green technologies.

In Indonesia, innovative capacities are in some cases translated into education and R&D activities. This is exemplified by the achievement of a group of three students from the Satya Wacana Christian University, whose work caught the attention of the online and social media community following their success at the Thailand Inventors Day 2020 event. The students presented an innovative product to tackle the issue of plastic waste—a bioplastic product made from cassava peel. In addition to reducing plastic consumption and waste, this product is biodegradable, thus contributing to sustainable development. Innovative capacity developments are also led by the government, including at the local level.[162] The municipality-owned transport company, TransJakarta, received the Sustainable Transport Award (STA) 2021 at the international transport conference, MOBILIZE 2020, in October 2020.[163] The company, which was the first to provide 'bus rapid transit' in South East Asia, continues to add electric buses to its fleet with a view to converting its entire fleet by 2030 and is investing in the construction bicycle lanes to support the city's green transition.[164]

It is important to note, however, that a low level of online discussion in terms of innovative capacities relating to environmental risks does not mean that innovation is not taking place. For example, while Morocco developed significant progress in cross-border clean energy investments as reported by the Green Future Index developed by the Massachusetts Institute of Technology (MIT) covering 76 countries, it still lags in terms of green patents and foodtech private investment.[165]

C. Innovative capacities relating to technological risks

Figure 3.22: Countries' awareness of innovative capacities relating to technological risks

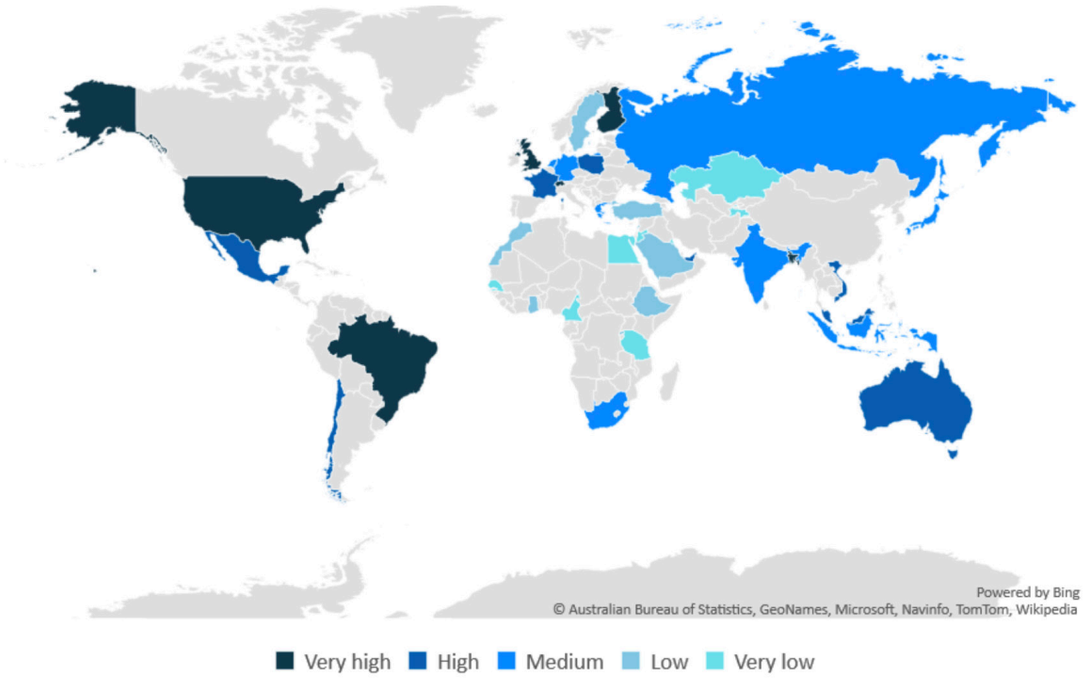


Table 3.10: Countries' awareness of innovative capacities relating to technological risks

Country	Mentions	Engagement	Awareness Index	Awareness Level
United States	990,460	12,592,080	67.05	Very high
Luxembourg	3,054	4,773	54.10	Very high
Bangladesh	2,736	50,770	51.18	Very high
Brazil	38,540	676,220	49.58	Very high
United Kingdom	164,680	1,419,780	47.69	Very high
Singapore	13,942	109,601	47.01	Very high
Switzerland	31,772	74,852	44.34	Very high
Finland	5,183	48,453	35.11	Very high
United Arab Emirates	25,706	91,671	34.95	High
France	68,613	459,720	30.06	High
Poland	56,094	222,440	28.21	High
Viet Nam	34,147	292,367	27.89	High
Australia	34,760	60,573	23.92	High
Malaysia	6,456	49,852	22.97	High
Chile	4,924	34,890	22.84	High
Mexico	17,007	130,500	22.36	High
Germany	150,180	159,140	22.28	Medium
Russian Federation	32,013	212,967	20.33	Medium
Greece	5,961	28,541	19.97	Medium
Japan	49,133	253,767	17.77	Medium
Netherlands	15,857	48,195	17.57	Medium
South Africa	9,423	50,225	17.03	Medium
India	125,260	590,020	16.96	Medium
Indonesia	17,873	104,620	16.95	Medium
Lebanon	2,253	10,195	16.09	Low
Sweden	10,355	19,073	15.21	Low
Morocco	1,699	7,754	12.73	Low
Ethiopia	146	673	12.33	Low
Turkey	49,287	76,233	11.22	Low
Rwanda	225	758	9.73	Low
Saudi Arabia	18,249	28,689	9.40	Low
Ghana	1,462	3,584	7.70	Low
Tanzania (United Republic of)	477	981	5.88	Very low
Jordan	2,656	1,464	5.20	Very low
Cameroon	263	472	5.10	Very low
Kazakhstan	767	1,194	4.49	Very low
Senegal	1,217	816	4.18	Very low
Egypt	7,294	2,657	2.01	Very low
Kuwait	590	159	1.89	Very low
Tajikistan	108	5	0.46	Very low

Note: Mentions and engagements are reported in absolute terms. In order to calculate the Awareness Index, we used a formula in which the two composites (mentions and engagement) were first standardized, then normalized and finally linearly combined. Please refer to Chapter 2—Methodology for more information about how the Awareness Index and awareness category level are calculated.

In the United States, peaks in mentions (with an Awareness Index of 67 percent) relate to debates concerning the impacts that the applications and activities of tech giants have on democratic systems. In several instances, major tech companies were accused of having influenced elections[166] through the use of algorithms and other means.[167] To address this issue, the United States government intends to establish new regulations to ensure tech giants innovate more responsibly.[168]

In Luxembourg, the peak of mentions (with an Awareness Index of around 54 percent) pertained to the European Investment Bank's (which is based in the country and serves the EU) first ever digital bond issuance on a public blockchain, which aims to encourage the digitalization of capital markets.[169] The objective is to allow capital markets to benefit from faster settlement speeds, a reduction of intermediaries and fixed costs as well as an increased transparency as it is easier to see the identity asset owners and to track trading flows and secondary market transactions. In addition, the European Investment Bank established a EUR 150 million Artificial Intelligence Co-Investment Facility to support private sector-led AI innovation.[170] The government of Luxembourg also actively leverages technologies to address related risks. For instance, during a trade mission to South Korea in 2019, Luxembourg presented its key initiatives relating to data management, analysis, storage and even distribution, demonstrating innovative features in IT security.[171] In Luxembourg, the focus is more on investments, and less on regulations and policies as is the case in the United States.

In the United Arab Emirates, significant online activity was driven by Gitex Technology Week, held in December 2020 at the Dubai World Trade Centre. A major tech event, Gitex was also the biggest in-person technology event held worldwide during the COVID-19 pandemic.[172] Bringing together thousands of tech companies, start-ups and governments from about 60 countries, the event provided the UAE with the opportunity to reinforce its strong position in the technology industry as well as to emphasize its leadership role in the global recovery.[173,174]

Countries such as Bangladesh and Brazil also received high scores on the Awareness Index. In Bangladesh, the Prime Minister placed particular emphasis on the importance of skills and education to address future technological risks (such as cyberattacks[175]), but also to leverage the Fourth Industrial Revolution. The country's 2020 national skills development policy dedicates one of its pillars to skills development for emerging technologies and digital skills.[176]

In Brazil, the government also identified cyberattacks as a key issue affecting its economy, and is developing a strategy leveraging the latest technologies and solutions to address this issue.[177] The cybersecurity strategy, developed together with public sector bodies, technical experts and academia, foresees the implementation of innovations including the introduction of minimum cybersecurity requirements in public tenders, national encryption systems and the intensification of anti-piracy policies.[178]

3.2.2.3 Conclusion

Overall, the share of mentions related to innovation as a means to leverage knowledge and future skills to address risks stood at 13.22 percent globally, indicating limited awareness and capacities. At the same time, the level of innovative capacities also varied per risk category.

Over the period of analysis, between June 2019 and May 2021, the trend in the share of innovation mentions related to technological risks was the highest at the global level, and slightly increased over the study period. The trend in the share of innovation mentions related to environmental risks also rose over the period, while the share of innovation mentions related to health risks remained stable. Although the absolute number of mentions concerning health risks exploded in and around March 2020, only a small proportion of these focused specifically on innovation itself and mostly concerned the political discussions around the development of vaccines and the means to contain the pandemic.

Innovative capacities are considered essential in leveraging the four knowledge dimensions—enabling environment, economy, RDI and science, and education. Enabling environment and economy featured among the top three dimensions for which innovative capacities are significant across all risks. This shows that innovation—understood as experimenting, pioneering and inventing—is crucial when it comes to designing or adapting policy or regulatory frameworks to address future risks. In practice, the ability of governments to adapt their policies in response to COVID-19 by introducing both short- and long-term measures was key to mitigating the economic and social impacts of the pandemic. Often coupled with policy initiatives, investments and access to finance for companies are also important in addressing future risks. These can take the shape of recovery plans and (green) deals for governments or digital strategies for companies.

Moreover, as innovative capacities heavily depend on the surrounding macroeconomic environment, significant disparities exist between countries. In other words, innovative capacities are essential to addressing risks everywhere, but countries are not equally equipped to respond to risks and significant disruptions. This is particularly the case for countries where awareness of innovative capacities appears to be limited—such as Cameroon, Egypt, Kuwait, Kazakhstan, and Tajikistan[179]—which constrains their readiness to address future risks. These countries may face difficulties adapting to major disruptions and struggle to foster sustainable development. At the other end of the spectrum are countries such as Brazil, Luxembourg, Switzerland, the United Kingdom and the United States,[180] which demonstrate a high level of awareness of innovative capacities when it comes to leveraging knowledge and future skills to address risks. This high level of awareness will help them create knowledge and provide solutions to urgent global challenges.

While this report helps to assess the awareness of innovative capacities in the countries studied, it is equally important to understand the causes or factors that shape and influence transformative capacities in order to ensure adequate progress. Hence, future studies are required to examine countries' socio-economic systems in greater depth to provide policy recommendations for upgrading their transformative capacities.

ENDNOTES

1. The number of data points refers to number of mentions, not engagement, as the latter is derived from the former.
2. In absolute terms, health risks in connection with knowledge dimensions and future skills accounted for around 21 million mentions, followed by environmental risks with around 16 million mentions, and technological risks with 10.5 million mentions.
3. Including wildfires in Australia and the Amazon, floods in Indonesia, cyclones in India and Bangladesh, and hurricanes in Nicaragua and Honduras. 2020 was a particularly bad year in terms of the number of climate disasters, but there is cause for hope in 2021; see Hoffmann, 2021.
4. Some examples of policy responses include national strategies concerning climate change (e.g. Kenya's climate change bill), the European Green Deal and other schemes fostering green investments (e.g. the Bangladesh Climate Change Trust), or biodiversity policies that seek to protect ecosystems and combat climate change (e.g. the EU 2030 Biodiversity Strategy).
5. European Environment Agency, 2021b.
6. See Fridays For Future, 2019.
7. Sengupta, 2019.
8. See UN DESA, 2019a.
9. See UN, 2019.
10. See UNFCCC, 2019.
11. See United States, Department of State, 2021a.
12. HuffPost, 2019.
13. Branford and Torres, 2021.
14. Kituyi, 2020.
15. Fulker, 2020.
16. Walch, 2019.
17. Stainer, 2021.
18. Finland's Presidency of the Council of the European Union, 2019.
19. See UNSDG, n.d.
20. UNFCCC, n.d.-a.
21. Harvey, 2019.
22. Cox, 2019.
23. See UN DESA, 2019a.
24. Rosenblatt, 2019.
25. NPR, 2019.
26. UNFCCC and WFP, 2020.
27. See UNFCCC, 2015.
28. Harvey, 2020.
29. IISD, 2021.
30. Ibid.
31. World Resources Institute, 2021.
32. See UN, n.d.-b.
33. Acosta, 2020.
34. United Kingdom, Medicines and Healthcare products Regulatory Agency, 2017.
35. European Parliamentary Research Service, 2020b.
36. Kim and Fung, 2020.
37. Hern, 2020.
38. RFI, 2020.
39. UN, 2020.
40. See EC, n.d.
41. Luxinnovation, 2020.
42. See Tickle, 2020.
43. Wu and Litvinova, 2021.
44. Ians, 2021.
45. WHO, 2021a.
46. See Gavi, 2021b.
47. Australia, Prime Minister, 2019.
48. Farr, 2019.
49. Australia, Prime Minister, 2019.
50. Norman, 2019.
51. Truu, 2019.
52. See Thales, n.d.
53. Ibid.
54. Poland, U.S. Embassy and Consulate, 2019.
55. The considerable difference observed between the number of mentions and engagement is explained by the fact that, although they are linked (an engagement relies on a mention), there can be a low number of mentions but a very high engagement—or vice-versa—depending on the interest, participation and behaviour of a country's online users regarding a specific topic.
56. United Arab Emirates, Ministry of Interior, 2020.
57. Khaleej Times, 2020b.
58. Khaleej Times, 2020c.
59. Kuwait, Embassy of the People's Republic of China, 2020.
60. UNICEF, 2020.
61. Karuhanga, 2019.
62. See PICSA, n.d.
63. Ibid.
64. Nkurunziza, 2020.
65. Rwanda, Ministry of Environment, 2020.
66. Republic of Rwanda, 2019.
67. IISD, 2019.
68. Pearson, 2020.
69. Rees, 2021.
70. Montes, 2021.
71. Government of Chile, 2020b.
72. Gavi, 2021a.
73. EC, 2020c.
74. Ibid.
75. Ibid.
76. See GAC Group, 2020.
77. See Firjan, 2020.
78. The nationally determined contributions (NDCs) of each party are central elements for implementing the Paris Agreement. "NDCs are national climate plans highlighting climate actions, including climate related targets, policies and measures governments aims to implement in response to climate change and as a contribution to global climate action". (UNFCCC, n.d.-c.)
79. Government of Chile, 2020a.
80. NDC Partnership, 2020.
81. Patrick, 2021.
82. United States, Department of State, 2021b.
83. United States, The White House, 2021.
84. See Direktorat Jenderal Pengendalian Perubahan Iklim, 2020.
85. See World Bank, 2020a.
86. See IISD, 2020.
87. Hassan, 2020.
88. Huawei, 2020.
89. World Summit on the Information Society, 2019.

90. Singapore, Smart Nation, 2019.
91. Kit, 2019.
92. Schmid, 2020.
93. Swissinfo, 2020.
94. Switzerland, National Cyber Security Centre, 2021.
95. Miller, 2019.
96. Diem, n.d.
97. Ibid.
98. See OAS, 2020.
99. See Krigman, 2020.
100. See OAS, 2021.
101. Ibid.
102. Furman, Porter and Stern, 2002.
103. See Rubera and Kirca, 2012; See also Bowen, Rostami and Steel, 2010.
104. Akpan, 2020.
105. UNEP, n.d.-a.
106. Vetter, 2021.
107. EC, 2020d.
108. OPSI and MBRCGI, 2020.
109. IBM, n.d.-a.
110. Capgemini Research Institute, 2019.
111. EC, 2021b.
112. Singapore, The Infocomm Media Development Authority, 2020.
113. Sagar, 2020.
114. Ibid.
115. Choudhury, 2021.
116. Walch, 2019.
117. Frank and Dayekh, 2021.
118. See Fitzpatrick, 2020.
119. See Wen Li, 2021.
120. See Lee, 2021.
121. See Lin, 2021.
122. Ruche, 2021.
123. EC, 2020e.
124. See https://www.climateambitionsummit2020.org/.
125. Ibid.
126. The Climate Group, 2020.
127. See United States, Department of State, 2021a.
128. See Wilkins, 2020; See also CNA, 2020.
129. Kelso, 2020.
130. EC, 2020a.
131. EC, 2020b.
132. ED Markey, 2021.
133. See Ocasio-Cortez, n.d.; See also Schuelke-Leech, 2021.
134. BBC News, 2020.
135. Street, 2020.
136. Kestenbaum, 2020.
137. Crunchbase, n.d.
138. Ibid.
139. See Knowledge@Wharton, 2021.
140. HSD Foundation, 2019.
141. Government of the Netherlands, 2021.
142. Alvarez, 2021.
143. Ramirez, 2021.
144. Business Wire, 2020.
145. The considerable difference observed between the number of mentions and engagement is explained by the fact that, although linked (an engagement relies on a mention), there can be a low number of mentions but a very high engagement, or vice-versa, depending on the interest, participation and behaviour of a country's online users concerning a specific topic.
146. Patel, 2021.
147. Andzongo, 2021.
148. Mbodiam, 2020.
149. Vietnam Plus, 2020.
150. Government of the United Kingdom, 2019.
151. See Razer, n.d.
152. Razer, 2020.
153. See Bussacos and Paulsen, 2020.
154. Ibid.
155. See Novartis Foundation, n.d.
156. The Guardian, 2019.
157. White, Kelly and Speight, 2019.
158. Financial Times, 2020.
159. Government of the United Kingdom, 2020a.
160. Government of the United Kingdom, 2020b.
161. Murray, 2020.
162. Rosa, 2020.
163. Sandiputra and Inggita, 2020.
164. Tempo, 2019.
165. Wilson, 2021.
166. Richardson, 2019.
167. Room and Dwoskin, 2021.
168. Ibid.
169. EIB, 2021.
170. EIB, 2020.
171. The Government of the Grand Duchy of Luxembourg, 2019.
172. Khaleej Times, 2020a.
173. Ahmed, 2020.
174. Gulf Business, 2020.
175. See Risingbd, 2020.
176. See Government of Bangladesh, 2020.
177. See Mari, 2020.
178. Ibid.
179. Those countries scoring the lowest when summing their Awareness Index for collaborative capacities across the three risks.
180. Those countries scoring the highest when summing their Awareness Index for collaborative capacities across the three risks.

04

CONCLUSIONS AND RECOMMENDATIONS

04 CONCLUSIONS AND RECOMMENDATIONS

This edition of the Future of Knowledge Foresight Report series comes at a most uncertain time, in which countries are being forced to respond and adapt to a new normal by the unprecedented impacts of the COVID-19 pandemic. In this context, online discussions and debates have focused on how countries can scale up resilience, develop inclusive recovery plans, and shift toward more sustainable and inclusive development pathways. This report argues that to achieve this, countries must mobilize their transformative capacities to enable long-term transformations and actively respond to future disruptions.

With this goal in mind, this edition leverages alternative metrics based on big data and machine learning to provide an understanding of countries' transformative capacities and the extent to which they are prepared to utilize knowledge and skills to drive change, shift their current trajectories and minimize the root causes of risks. In doing so, it represents a first attempt to measure countries' preparedness through social media monitoring.

This concluding chapter will first take a step back by elaborating on the value-added nature of the transformative capacity model applied in this edition. It will then provide a set of recommendations for policymakers to leverage the development of collaborative and innovative capacities to power deep structural reforms in response to the underlying failures of development.

4.1 THE TRANSFORMATIVE CAPACITY MODEL: A FRAMEWORK FOR ADDRESSING FUTURE RISKS

The transformative capacity model is designed to inform stakeholders—including governments, businesses and citizens—on the readiness of their countries to adopt innovative and collaborative approaches and strategies in addressing future health, environmental and technological risks, from a knowledge and skills perspective. In doing so, this model helps shift the focus from post-risk interventions and mitigating vulnerabilities, towards the integration of anticipatory collaborative and innovative solutions and approaches to reduce the prevalence and severity of these risks. It is hoped that the experiences and solutions presented in this report will inspire leaders who seek to build and strengthen their countries' transformative capacities.

Figure 4.1: The transformative capacity model for future-ready societies

The proposed model focuses on three risks that are most likely to impact countries in the near, mid and long terms. By simultaneously analysing the dynamics of these risks and their interdependencies, the model aims to break up silos and acknowledge the need for holistic solutions that capture sustainable transformations. For instance, a break-through innovation aimed at protecting biodiversity can also have an impact on a population's health and well-being.

Likewise, this model recognizes that complex challenges cannot be addressed by a single capability, or by ready-made or rigid policies and frameworks. Thus, in addition to future skills, other dimensions of knowledge societies were introduced, as these appear to play significant roles in the preparedness of countries to respond to future risks. As shown throughout the report, knowledge dimensions and future skills are often used in combination, as they promote the diffusion and application of knowledge through well-functioning connected networks to tackle multifaceted risks.

Furthermore, a value-added quality of this model is its ability to collect and analyse millions of data points from online and social media sources, which form the basis for alternative metrics to measure awareness and develop timely interventions. This approach therefore complements traditional statistics and metrics, providing an additional angle of analysis to disentangle complex threats when attempting to design and implement fit-for-purpose solutions. Also, further studies may leverage the data collected and triangulate it with other traditional datasets to develop actionable policy recommendations.

4.2 KEY RESULTS

In studying the knowledge infrastructure of countries and their preparedness for technological uptake, previous editions of the Future of Knowledge Foresight Report series have warned that the countries analysed[1] have not reached their full knowledge potential. Efforts are therefore required to enable the growth of collaborative and innovative societies, and ensure their preparedness for absorbing and adapting to future threats. While recent disruptions such as the emergence of the COVID-19 pandemic—and the varied responses to it—tend to confirm this assessment, the present edition of the series adopts a forward-looking view to help countries: i) learn from previous experiences and crises; and ii) increase their preparedness in order to secure an inclusive, resilient and sustainable future.

This section sheds light on the main outcomes of the analysis to provide, as a first step, an overview of the main global trends relating to transformative capacities. This is intended to help stakeholders—ranging from policymakers to decision makers in the private sector and civil society—to better understand the extent to which societies are prepared to mitigate the impacts of health, environmental and technological risks. Thereafter, it focuses on the roles of knowledge dimensions and future skills in addressing these risks, while illustrating concrete solutions and practices that governments, the private sector and civil society should account for in responding to potential future risks.

4.2.1 Transformative capacities: Quo vadis?

By supporting countries to absorb, adapt and transform, transformative capacities are expected to play a key role in a world of increasingly complex and interconnected challenges. However, the analysis presented in this report shows that the collaborative and innovative capacities that are crucial to developing robust knowledge capabilities to tackle future risks remain limited. This suggests that countries are not fully prepared to face future disruptions and are therefore subject to heavier burdens on their systems (whether economic, social, political or natural). In practice, this means that countries are likely to experience difficulties in ensuring the continuity of services (in the fields of e.g. education and health), which will impact progress towards achieving the SDGs. This report also reveals that countries tend to rely on existing, traditional, rigid models that undermine their readiness to scale up transformative capacities to address future risks, as has been evident in their responses to climate change and the COVID-19 pandemic.

However, it is important to highlight that transformative capacities to address environmental and technological risks have globally increased in the past two years—albeit marginally. In fact, when looking solely at the period following the first wave of the pandemic, transformative capacities increased for all risks indistinctively. This may reveal that countries: i) have started drawing lessons learnt from this global crisis; and ii) have taken steps to increase their ability to leverage partnerships and cooperation within and between countries, and expand their capacities to innovate, create and localize knowledge in order to address future risks.

At the same time, the observations reveal that the slow pace at which countries are strengthening their transformative capacities does not match the magnitude and projected frequency of the disruptions studied. In other words, the complexity of the disruptions requires a more radical transformation at the national, regional and global levels.

Overall, countries feature a slightly higher degree of awareness when it comes to collaborative capacities. Although limited, innovative capacities are also important means for addressing future risks. While collaborative capacities are perceived as slightly more relevant when it comes to addressing health and environmental risks, innovative capacities are seen as more pertinent to addressing technological risks. This may be explained by the role played by the private sector when it comes to technological development, where innovative capacities represent a key differentiator.

Even though transformative capacities are generally increasing, clear differences between countries can be observed in the examined sample, with the most prepared countries all being high-income countries—mainly OECD countries, with the exception of the United Arab Emirates. At the same time, the least prepared countries are mostly low-income countries located in Africa, the Arab States region and Central Asia (Table 4.1). The picture is similar for each of the individual risks analysed.

Table 4.1: Most and least prepared countries across risks

Most prepared countries	Least prepared countries
United States	Kazakhstan
Switzerland	Tajikistan
United Kingdom	Cameroon
Australia	Tanzania (United Republic of)
United Arab Emirates	Egypt

This shows that there exists a significant gap in the preparedness of countries to absorb, adapt and transform following disruptions. Consequently, policymakers, the private sector and civil society are invited to proactively seek opportunities to strengthen their countries' transformative capacities and explore potential synergies—be they vertically or horizontally—through the development of collective actions to leverage innovations that will drive the capacities of countries towards their full potential.

4.2.2 Leveraging knowledge and future skills to address future risks

Embracing technological progress, and supporting the development of knowledge and modernized skillsets, have been identified as crucial actions for building resilience, creating sustainable growth and competing in a highly competitive world.

The data highlight that the enabling environment, economy, and RDI and science, respectively, feature as the top three knowledge dimensions to mitigate the impacts of future risks across both collaborative and innovative capacities.

Table 4.2: Top knowledge dimensions in mitigating the impacts of future risks across collaborative capacities

	Health risks	Environmental risks	Technological risks
Enabling environment	38.56%	58.57%	28.29%
Economy	28.88%	21.07%	28.89%
RDI and science	21.53%	15.68%	20.36%

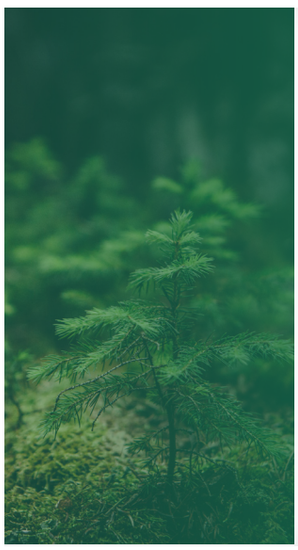
Table 4.3: Top knowledge dimensions in mitigating the impacts of future risks across innovative capacities

	Health risks	Environmental risks	Technological risks
Enabling environment	34.57%	56.16%	22.85%
Economy	30.85%	24.34%	29.34%
RDI and science	23.04%	13.75%	22.33%

More specifically, for both collaborative and innovative capacities, the enabling environment—understood as the ability of governments to develop and implement effective and relevant regulations, policies and schemes—features as the top dimension in tackling health and environmental risks, while countries tend to rely on their economic sectors to address technological risks.

For example, South Africa leveraged its collaborative capacities by engaging with other developing countries in order to establish policies and investment initiatives to tackle environmental risks. Particular focus was placed on climate change adaptation and cleaner forms of energy.[2] In the United Kingdom, record levels of investment were channelled into the tech sector in order to develop innovative measures in the areas of: i) data protection—an issue considered of prime importance for the competitiveness and development of the economy; and ii) data-driven decision-making, where part of the investments and solutions focus on AI/Robotics and machine learning, facial recognition technology, smart buildings and the Internet of Things (IoT).[3] Here, the economy dimension, fuelled by investments in the cyber-data space, plays a key role in addressing technological risks such as data theft.

While the skewed and unbalanced results across the knowledge dimensions can be explained by the intrinsic nature of risks, it may also be due to the normative view that governments are responsible for responding to, and financing solutions to, these risks, as well as the conventional perspective that individual acts are insignificant when responding to health and environmental threats. Consequently, governments often play a more prominent role in developing adaptive policy measures or regulations (that are sometimes complemented by financing schemes, especially those powered by the private sector). This has been illustrated during the COVID-19 pandemic, throughout which governments have been relatively active in devising support measures to tackle health issues but also socio-economic issues more generally. On the other hand, the ability of the private sector to adopt innovative and anticipatory approaches through investment in, or development of, new technologies and/or technological solutions has been paramount in addressing technological risks. This is often facilitated by government efforts to institute a favourable enabling environment that supports and incentivizes public and private research, development and innovation activities, as well as public–private partnerships.



Box 4.1: Leveraging the enabling environment to address environmental risks

To combat environmental degradation and promote sustainability, the United Nations Statistical Commission has approved a statistical standard, the System of Environmental Economic Accounting – Ecosystem Accounting (SEEA-EA), which is aimed at "measuring the ecosystem services, tracking changes in ecosystem assets, and linking this information to economic and other human activity".[1] The SEEA-EA also supports SDG monitoring—for example, in terms of the sustainability of cities by quantifying open access to urban green spaces (SDG 11), and the protection of terrestrial ecosystems by assessing modification, degradation and restoration of biodiverse areas (SDG 15).[2] For instance, India, led by the country's Ministry of Statistics and Programme Implementation, has devoted tremendous effort to adopting this innovative system through a collaboration with the European Union via the EU funded Natural Capital Accounting and Valuation of Ecosystem Services (NCAVES) project, the United Nations Environment Programme (UNEP), the United Nations Statistics Division and the Secretariat of the Convention of Biological Diversity (CBD).[3] The SEEA has also been used in other countries to assist policymaking processes and support sustainability agendas, e.g. the National Water and Sanitation Master Plan in South Africa, which was guided by ecological extent and condition accounts for rivers.[4]

Notes: 1. UN, 2021; **2.** Eurostat, 2021; **3.** UNEP, 2021b; **4.** See Centre for Environmental Rights, 2019.

Box 4.2: Leveraging RDI and science to address health risks

Online activity concerning RDI and science relating to health risks is mostly driven by the intensive and innovative research for the development of the COVID-19 vaccine. For instance, the clinical trials for the Sputnik V vaccine in the Russian Federation were launched in June 2020 by the Gamaleya Research Institute, part of Russia's Ministry of Health, and reached Phase 3 in September 2020, with an efficacy rate of 91.6 percent.[1,2] Later in November, the mass vaccination campaign started in Russia. Additionally, COVAX, a collaboration between the Coalition for Epidemic Preparedness Innovations (CEPI), Gavi, The Vaccine Alliance, and WHO with UNICEF, raised online attention as it accelerated the development and manufacturing of vaccines while ensuring fair access and delivery.[3] This coalition facilitated a vaccine rollout whereby Jordan, for example, received a shipment of 40,950 doses on 4 July 2021.[4]

Notes: 1. Sputnik V, n.d.; **2.** Foltynova, 2021; **3.** See CEPI, n.d.; **4.** EU Neighbours, 2021.

Box 4.3: Leveraging the economy dimension to address technological risks

The United Arab Emirates, the second most targeted country in the world in terms of cybercrime—with an estimated cost amounting for $1.4 billion per year, according to the Center for Strategic and International Studies (CSIS) and McAfee[1]—has seen an increase in cyberattacks of more than 190 percent following the shift towards remote working.[2] Aware of the importance of addressing this technological risk, given its impact on the economy and the increasing reliance of the country on digital technologies, a new national cybersecurity council has been tasked with developing laws and policies to strengthen cybersecurity. The council will also be in charge of setting up a strong National Cyber Incident Response Plan to allow quick and coordinated response to cyber incidents.[3]

Notes: 1. McAfee and CSIS, 2018; **2.** Arabian Business, 2021; **3.** The Arab Weekly, 2020.

While education, technology and future skills are perceived as being less important, comparatively, than other knowledge dimensions, the former must not be neglected, as the abilities of countries to absorb shocks and transform ultimately rely on human capital, as well as the broader technology infrastructure available.

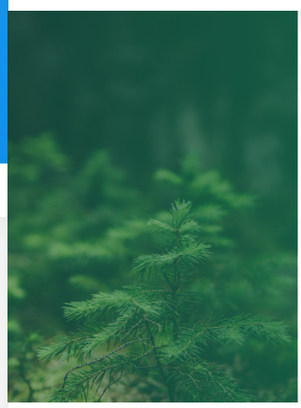
Table 4.4: Lowest-scoring knowledge and future skills dimensions across collaborative capacities

	Health risks	Environmental risks	Technological risks
Education	7.27%	2.99%	10.29%
Technology	1.23%	1.08%	9.11%
Future skills	2.53%	0.61%	3.06%

Table 4.5: Lowest-scoring knowledge and future skills dimensions across innovative capacities

	Health risks	Environmental risks	Technological risks
Education	7.71%	3.09%	9.59%
Technology	0.98%	1.87%	9.65%
Future skills	2.85%	0.79%	6.24%

Notably, future skills are perceived as less important in tackling environmental and technological risks, while the technology dimension scores the lowest in relation to health risks. It is worth noting that the latter does not imply that these dimensions are not relevant or impactful, but are rather not well-leveraged in these countries to mitigate future risks. Nevertheless, there have been remarkable experiences and practices exemplifying the roles of collaboration and innovation in education, technology and future skills to transform and alleviate the ramifications of potential risks.



Box 4.4: Leveraging education to address environmental risks

In the United Kingdom, a series of one-hour interactive Zero Carbon Britain webinars were organized in 2021,[1] hosting speakers who have hands-on experience in implementing projects that support the economic recovery from the pandemic whilst moving the country closer to net-zero carbon emissions and increasing societal resilience.[2] Similarly, in France in February 2021, a hackathon was organized to raise awareness among youth on sustainable food and its impact on climate, biodiversity and human issues.[3] Meanwhile, the India–Australia Circular Economy Hackathon was organized as a forum for students and MSMEs to showcase innovative ideas and share knowledge about the development of a circular economy throughout the value chain of the food industry.[4]

Notes: 1. See Centre for Alternative Technology, n.d.; **2.** Centre for Alternative Technology, 2021; **3.** EMLV, 2021; **4.** India, Ministry of External Affairs, 2021.

Box 4.5: Leveraging future skills to address health risks

In Lebanon, online activity relating to future skills and health risks was notably driven by the multifaceted crises and consequent pay cuts that have forced many doctors and nurses to seek work abroad.[1] As skills development is critical to ensure a comprehensive and inclusive recovery from the impact of these crises, the ILO and its International Training Centre (ITC-ILO) launched the Skills Academy Lebanon in December 2020, with contributions from UNICEF, the Italian Agency for Development Cooperation and the Netherlands. The programme provides customized online training, aimed at developing the capacity of stakeholders in the technical and vocational education and training sector, thereby enabling learners to contribute to the recovery of the country—particularly those working in hard-hit sectors such as health care.[2]

Notes: 1. Lewis, 2020; **2.** ILO, 2021a.
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Box 4.6: Leveraging technology to address technological risks

In February 2020, the European Commission announced that it had decided to use the Signal[1] application for public instant messaging between European Commission staff and people from outside of the institution. One of the main objectives of this was to increase the security of its communication and therefore add an additional layer of protection against potential technological risks which could lead to loss or theft of critical information. Based on an innovative encryption protocol and open-source technology, the use of this application therefore represents a strong shift towards the protection of official communications.[2,3]

Notes: 1. See https://signal.org/en/; **2.** Dussutour, 2020; **3.** Cerulus, 2020.

4.3 RECOMMENDATIONS

It is a pivotal moment for countries to take bold and transformative actions to recover from the COVID-19 pandemic and ensure a sustainable and inclusive development path, as highlighted in the 2030 Agenda. This edition of the Future of Knowledge Foresight Report series reveals that despite the disruption brought about by the pandemic globally, countries' transformative capacities are improving marginally; a drastic change in the way we do business, however, is vital to boost these capacities and foster countries' resilience and transformation. If not addressed, this will undermine countries' ability to leverage their knowledge infrastructure, leaving them subject to severe negative impacts as disruptions erupt in the areas of health, environment and technology.

The findings of the present report highlight that whenever attempting to mitigate risks, both the private sector and government primarily seek to enhance the policy and regulatory environment, and to capitalize on RDI and science. While these capabilities are all-important to tackle health, environmental and technological risks, other dimensions such as education, technology and future skills should not be overlooked, especially when coming across complex and interrelated threats and risks. In fact, education, technology and future skills have benefited from some level of transformation following the COVID-19 pandemic, with governments increasingly focussing on upskilling the workforce and preparing them to face future challenges as they arise.

Overall, more needs to be done to strengthen transformative capacities globally and to ensure that countries develop and integrate sustainable capabilities in their systems to better respond to future disruptions. By showcasing the various ways in which the public and private sectors can leverage collaboration and innovation in deploying knowledge to deal with contemporary challenges, this report aims to inspire national leaders and decision makers to advance their transformative capacities based on holistic, resilience-based approaches. This requires that countries acknowledge our planet is in crisis and that we need to revisit our assumptions that change is impossible or costly. Thus, additional resources should be mobilized towards the advancement of the knowledge environment and skills ecosystem, which are perceived as the main pillars to ensure countries' preparedness and resilience to address future risks.

1 Design and implement a nationwide multi-stakeholder SDG framework

The SDGs present a comprehensive and transformative approach that enables countries to realize their full potential while developing resilient societies. Thus, a risk-based management approach should consider the overarching framework of the SDGs, which facilitates common understanding of the actions to be taken at country-, institution- and company-level to address key vulnerabilities.

Through the establishment of effective multi-stakeholder engagement, government, the private sector and civil society are all involved in the identification of national priorities as well as SDG monitoring. This engagement would in turn ensure an open, collaborative, participatory and iterative process that reflects a nationwide approach to the achievement of the SDGs. Nevertheless, although the SDG framework should be country-based, leaders need to take a higher-level whole-world perspective to account for global interconnectedness and map a shared approach.

It is further recommended that countries conduct gap assessments focusing on the 'as-is' and 'to-be' when it comes to their capacities (collaborative and innovative) and capabilities (related to knowledge dimensions and future skills). This could be the basis for developing an evidence-based SDG framework for higher resilience detailing a roadmap of actions that could be undertaken to bridge any gaps observed in an effort to reduce risks and build resilience. For example, the Government of Luxembourg mandated the OECD to assess the management of the COVID-19 crisis, taking a holistic view on the health system and the economic and social dimensions, while reflecting the specificities of the demography of Luxembourg. Experts were asked to provide specific recommendations following the SDG framework and to share relevant good practices from other countries in order to help Luxembourg identify gaps in its transformative capacities and the actions that should be taken to improve them.[4]

2 Prioritize skills as the most valuable asset for future-proof human capital

While future skills are increasingly recognized as a key capability, most countries have limited visibility of the current state of play in terms of skills needs. This, in turn, prevents them from designing and implementing policies that can equip the labour force with the skills of the future.

Thus, countries need to develop an evidence-based, long-term skills strategy mobilizing a wide range of actors at the national level (including the private sector and all national policymakers across different ministries and administrations) and the international level (through bilateral/multilateral cooperation).

Given the complexity and magnitude of investments required for the deployment of an effective skills strategy, the full engagement of the local and international private sectors is key. Building on best practices, key milestones for the development of an inclusive and cross-sectoral national skills programme are:

A Defining future-oriented objectives for the type and volume of strategic skills necessary for meeting the country's needs in the short, medium and long terms.

B Measuring gaps in the attainment of strategic skills, given the target objectives set for the country and the 'as-is' situation.

C Defining measures for addressing the identified gaps in close collaboration with the private sector. Private sector actors are in direct contact with the workforce and the market, and at the core of labour demand. Their knowledge of market needs can help prioritize the most effective means of closing the skills gap.

D Developing a mutually beneficial collaboration framework that facilitates and leverages the involvement of the private sector in the implementation of the skills strategy. The only way for a country to upskill its workforce at scale is to leverage the experience and capacity of the private sector to deliver upskilling programmes.

A good example of strategic upskilling policy measures is France's implementation of the Regional Employment and Training Observatory.[5] The objective of this observatory, which relies on an AI platform, is to collect, monitor and assess labour market data (in terms of job vacancies, job descriptions, CVs, available trainings, etc.); analyse companies' current and future skills needs; identify the skills gap between companies' future skills needs and current individuals' skills; and suggest training to fill the identified skills gap. In doing so, it aims to match labour supply and demand, thus enabling an effective upskilling of citizens in a way that will be relevant both in the short and long terms.

3 Apply scenario planning and foresight approaches in developing solutions to address future risks

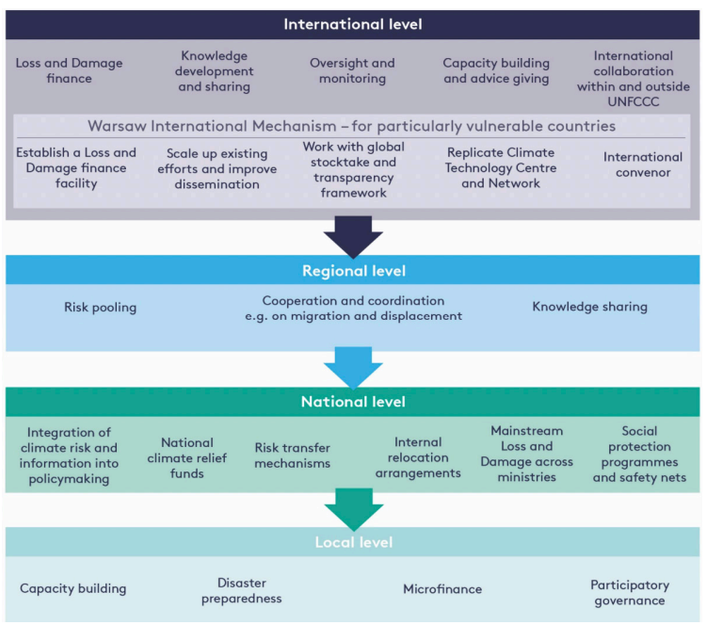
In order to prepare for, and address, increasingly complex and multifaceted risks, governments and other stakeholders should develop foresight capabilities in their response and recovery strategies. Foresight planning enables decision makers to anticipate the future, influence it, and regain a sense of direction. The latter requires horizon scanning, designing solutions to scale and purpose, and the early adoption of innovations.

Countries should also more systematically apply scenario planning/strategic foresight methodologies. These are often used to assess and respond to complex problems with multiple hypotheses and a high degree of uncertainty.[6] Scenario analysis starts by considering what might happen, and then explores a range of plausible future trajectories. They can therefore be used for detecting early warning signs and for strategy development—for instance, by securing international partnerships for interventions in case of disruptions. Consequently, this will allow countries to uncover probable future scenarios, trends, drivers and repercussions and, in turn, develop integrated risk-mitigation strategies to avert unfavourable futures. This is the case for a recent initiative developed by Europe's Mediterranean countries, which committed to strengthen cooperation in the economy, technology and environment to address global challenges—primarily climate change.[7] The rationale for such cooperation stems from the increased likelihood of these countries experiencing climate disasters in the short and medium terms.

4 Stakeholders should act collectively – within and between countries

Setting up a community of practice and international partnerships to foster the exchange of knowledge and good practice is critical when it comes to boosting recovery and strengthening transformative capacities. Such a community of practice facilitates the transfer of lessons learned, and both incentivizes and inspires countries to adopt open knowledge systems, thus avoiding bureaucratic and centralized decisions. Likewise, the participation of practitioners and other non-traditional actors along with policymakers from the very early stages of a commissioning system that brings together diverse outlooks and aspirations ensures that efforts are effectively mobilized towards a shared future.

Figure 4.2: Example actions on loss and damage at different geographical levels



Source: Byrnes and Surminski, 2019.

Figure 4.2 presents a set of actions that should be taken at different levels to mitigate the effects of climate change, as per the Warsaw International Mechanism on Loss and Damage (WIM).[8] The proposed framework aims to facilitate knowledge development and sharing across all stakeholders, be it vertically or horizontally. Collaboration can be materialized in several ways, including through capacity building and monitoring and reporting activities, investment, governance, and others geared towards achieving impact.[9]

Cross-sectoral collaboration is not only essential to foster the exchange of knowledge and best practices but also to encourage the provision of the necessary financial support for the development of new solutions to address complex risks and reinforce countries' transformative capacities.

The only way to move forward, when facing a future that undoubtedly carries natural, economic, health and other risks, is by countries leveraging transformative capacities through knowledge dimensions and future skills. This edition of the Future of Knowledge Foresight Report series recognizes that many countries have taken incremental steps forward in reaction to the disruptions brought about by the COVID-19 pandemic. Nonetheless, bold actions and drastic transformations are needed for a full post-pandemic recovery; and, more than that, to anticipate and prepare for forthcoming crises. A collaborative long-term vision is essential; whereas collaboration and innovation are the most valuable approaches to designing relevant and effective policies, different stakeholders can change the rules of the game. To this end, the good practices, solutions and recommendations featured in this report can inspire and encourage policymakers and other stakeholders from the private sector and civil society to leverage partnerships and sustainable innovation to foster participatory and inclusive development.

ENDNOTES

1. The same 40 countries analysed in this report, see Chapter 2.
2. News24, 2021.
3. Cotton, 2021.
4. OECD, n.d.
5. See OREF Grand Est, n.d.
6. Athika, n.d.
7. Gatopoulos and Becatoros, 2021.
8. See UNFCCC, n.d.-e.
9. Byrnes and Surminski, 2019.

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This edition of the Future of Knowledge Foresight Report series comes at a time of considerable global uncertainty. It therefore seeks to inform ongoing discussions regarding the means for countries to scale up their resilience, develop recovery plans, and shift toward more sustainable and inclusive development pathways.

Globalization creates opportunities but also increasingly complicated and interconnected threats.

This report focuses on risks concerning human health, the environment and technology—all key areas in which the impacts of such risks are likely to be most severe.

Its objective is to assist countries in developing transformative capacities to achieve greater resilience in facing these risks.

Using the transformative capacities model, this report employs big data and machine learning to assess countries' preparedness to face risks.

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