SECTION 5

Uncertainties, Risks, Shocks, and Black Swans

The operational areas identified in this Foresight are intended to enable the realization of the aspirations of the Filipino people towards a state of wellbeing. Various approaches and particular technologies have been identified for this 30-year journey towards inclusive and equitable development. This section identifies the uncertainties, risks, and shocks that may arise during the implementation of the science, technology, and innovation (STI) inputs for the national development agenda, intended to benefit 144 million Filipinos by the year 2050.

Will growth and scarcity generate their own technological and social solutions?

There is disagreement on the nature of the problem (Warner et al. 1996). There are those who feel that the limits imposed by scarce resources can be resolved technologically and socially even as the human population continues to put pressure to satisfy its needs. Others propose to impose radical measures for population control. While a third approach is to balance "continued growth with the preservation of the world ecosystem" (Warner et al. 1996; Vitousek et al. 1997).

The COVID-19 pandemic has exposed in a more pronounced manner the fragile situation of the global and local economies and the inequalities that have been created in the long history of development (World Bank 2017; UNIDO 2018; FAO 2020b; UNCBD Secretariat 2020).

The technosphere, also mentioned in earlier sections of this Foresight, is a "network whose nodes, or intersection points, are people and technological artifacts. Energy, materials, information, and other essentials flow through the links that connect these nodes" (Haff 2013, 2017). Its components are "the world's humans, its transportation, communication, information, power, financial, education, and health systems and the world's cities, farms, militaries, bureaucracies, and other social-technological organizations, all technological systems and artifacts requiring energy and materials for their function or maintenance, as well as humans, are components of the technosphere." Haff (2017) considers the technosphere as the defining system of the Anthropocene, the unofficial name of the current historical epoch.

The technosphere has brought about new forces and conditions that have radically changed our environment and is now tasked with the challenge of recycling its products, by-products, and waste materials—including its huge mountain of products that have become obsolete (Haff 2013).

This section will deal with the functionality of the STI system—i.e., its ability to withstand, survive, sustain its activities in the face of uncertainties, risks, and shocks—when events that are not supposed to happen take place. Since human beings are vital to the survival of the technosphere, managing the interaction between human beings and technology, including their attendant material and energy flows, is the key to the functionality of the technosphere (Haff 2014). Human beings provide the brain power, the imagination, and creativity to keep the system going in the face of uncertainties and risks.

The Uncertainties, Risks, and Shocks

Recent progress in science and technology has enabled us to see more, detect more, sense more, and know more—moreso at our moments of dire need. Nevertheless, as we pursue new knowledge and innovation, there are uncertainties, risks, and shocks that have to be dealt with. Rapid and complex developments in the social, economic, environmental, political, and technological scene at the global and national domain are accompanied by varying levels of uncertainties, risks, and shocks, also known as “black swans,” that have an impact on our ability to create wealth and promote national well-being (Magruk 2017).

Using available information and tools to gather data allows us to gain an idea of the nature of the uncertainty, risks, and shocks that may be encountered during the development of STI. Predicting the consequences of such vulnerabilities is a big challenge and at times may not be possible at all. Nevertheless, the intent of foresight is to identify the possible uncertainties, risks, and shocks and determine their possible positive or negative impact, time of occurrence and extent of disruption or impact.

The “black swan” is a highly improbable and shocking occurrence and is characterized by three attributes (Taleb 2010):

- It is an outlier: “lies outside the realm of regular expectations, because nothing in the past can convincingly point to its possibility.” (Taleb 2010)
- Extreme impact
- Can only be explained after the occurrence

An example of a black swan occurrence is the 9/11 attack on the World Trade Center in New York City. It is an uncommon event that resulted in the loss of many lives, destruction of property, and the tightening of travel security. Only after the event was an explanation of the circumstances that led to such an incident made possible.

The rapid pace and increasing complexity of developments, globally and locally, exacerbate the occurrence of black swan, as well as uncertainties and risks. Aven (2015) proposed a classification of black swan events as follows:

- Unknown unknowns such as 9/11 attack on the World Trade Center
- Unknown knowns (knowledge of the possible risk is known by others) such as the crew of a fishing boat deciding to face the storm, ending in tragedy.
- Events with negligible probability of occurrence such as accidents in an oil and gas installation.

A more rigorous level of analysis of these vulnerabilities will be important inputs in the creation and assessment of scenarios that will be the basis for strategies in the conduct of specific STI activities. For purposes of this Foresight, it might suffice to list the possible uncertainties and risks that might be perceived in the light of current circumstances; black swans, by definition, are all but impossible to identify.

In a report for McKinsey and Company, Baumgartner et al. (2020) identified vulnerabilities in the industrial supply chains that can affect efficiency, and provided estimates on their magnitude of disruption, frequency, and ability to be anticipated. These uncertainties have been identified in the context of industrial supply chains but can nevertheless affect any—and possibly even all—the operational areas in this Foresight. The following are sample disruptions classified by the estimated lead time in which they can be anticipated:

- Days
  - Acute climate events (hurricanes, typhoons)
  - Idiosyncratic event (dirty bomb)
- Weeks
  - Extreme pandemic
  - Financial crisis
  - Regulation and changes thereof
  - Super volcano eruption
  - Pandemic
  - Acute climate event (heat wave)
- Months
  - Global military conflict
  - Trade disputes, collapse of regional coalitions and withdrawal from trade agreements
  - Local military conflict
- Difficult to anticipate
  - Meteoroid strikes

- Solar storms
- Extreme terrorism
- Systemic cyberattack
- Major geophysical event
- Terrorism
- Human-made disaster
- Common cyberattack
- Counterfeit
- Theft

In addition to the abovementioned vulnerabilities, the global trends identified in previous sections of this report will also affect the Philippines' STI activities. Viewed in a larger context, the above vulnerabilities will also disrupt the functions of the knowledge infrastructure, the flow of knowledge, and the mobility of STI human resources. In addition to the disruptions identified in the McKinsey Report (Baumgartener et al. 2020), there are also other issues that can stop, interrupt, suspend, hamper, delay and retard STI activities, especially the deployment of technologies in the operational areas of this Foresight. Some of these vulnerabilities may be similar to those in the McKinsey Report, albeit occuring locally. This list is by no means complete, but we offer the following areas as possible sources of uncertainties, interruptions, and delay in the STI sector:

- Natural disasters in areas where field experiments are being conducted: typhoons, volcanic eruptions, earthquakes, droughts, floods, pests, diseases
  - Data collection and the destruction of the scientific equipment, e.g., Doppler Tower recently destroyed by Typhoon Rolly in Catanduanes
- Stresses, possibly brought about by climate change, that will affect experiments in crops, livestock and poultry, and fisheries
  - Abiotic stresses like drought, soil nutrient deficiencies, pollution
  - Pests and diseases of humans, animal, and plants including zoonotic disease
- Disruptions in the STI Knowledge Infrastructure (K-12 schools, public and private HEIs, Voc-Tech training centers, research institutions)
  - Quality of training in the STI knowledge infrastructure
  - Disruptions in the information infrastructure especially in telecommunications
  - Demand for talent to address development problems such as environmental pollution, technical assistance to MSME and access to cost-effective technologies to address minimum basic needs
  - Migration of STI talent through the OFW program of the Philippine government
  - Competition for highly trained STI talent from other countries
  - Protectionism by countries resulting in the restriction of access to new knowledge

    - Cost-effective online courses from more advanced countries might render some the curricular offerings in Philippine HEIs redundant.
- Major changes in the development agenda and support for STI brought about by change in government leadership
    - On the positive side, a significant increase in STI investment from the public and private sector may challenge the absorptive capacity of the research & development community
    - Resistance to technological change (Mokyr 1992)
- Management of STI Activities
    - Increase of inequality
    - Unintended consequences of technologies such as displacement of labor, generation of toxic wastes, etc. (Acemoglu and Restrepo 2019)
    - Disruption in the supply chain of research equipment and materials
    - Funding of STI activities
- Flow of R&D funds is hampered by absorptive capacity
    - Regulatory regimes affecting the timely procurement and supply of research materials and equipment
    - Indicators for assessing scientific activity and compliance with global initiatives such as the SDG, the evaluation of scholarly publications and the target density of R&D workers per million population. (Acemoglu et al. 2014)
    - Research Management and Grants Administration Systems in public and private institutions engaged in R&D
    - Reliable and updated database on public and private investments in R&D
    - Market-driven R&D agenda
    - Reorganization of DOST
    - Coordination among DOST, DA, DENR, DOH, DICT, CHED, TESDA, SUCs, Professional Regulation Commission, Private Sector R&D, National Innovation Council
    - Implementation laws affecting STI
    - Communication program to improve public understanding of science and to promote a culture for innovation
- Competition from other countries, especially ASEAN, that will render some of our R&D work redundant.
- Recovery from the negative impact of the COVID-19 pandemic

Anti-Science Movements

Past events such as the Luddites, the Scopes trial, the Nazi efforts on eugenics, attacks on genetics, space science, and the vaccines have fueled the intensification of the current antiscience movement which is increasingly becoming global. These assaults have been picked up by some politicians to further their political careers. When decisions of great impact are made based on biased information, the long-term, sometime irreversible effects can be disastrous. For a country like the Philippines that has to catch-up in science, technology, and innovation, the antiscience movement can have a crippling effect and will further delay efforts to address uniquely local problems (Hotez 2021).

Conclusion

Resilience and agility in the governance of STI will allow us to cope with uncertainties, risks, and shocks, whether they occur as isolated events or in combination. Holling (1973) defines resilience as the ability of an ecosystem to "absorb changes and still exist." Agility is defined as the "ability of an organization to respond rapidly to changes in demand, both in terms of volume and variety" (Christopher et al. 2000). It is noted that resilience and agility may overlap in certain situations.

There are four concerns that need to be seriously considered in the management of response to uncertainties, risks and shocks:

First, coping with these vulnerabilities should not create nor exacerbate inequalities. Inequality is a barrier to the realization of the full potential of human beings (Cozzens 2008, 2016) and STI must not be used to create these inequalities. The COVID-19 pandemic has intensified the existence of these inequalities which can no longer be ignored such as access to health care, livelihood, and continuous learning.

Second, our enthusiasm to generate new technologies has messed up our environment. We will now have to correct the negative effects of the technosphere that we created especially in the recycling and disposal of waste materials and products that have outlived their usefulness. This seeming neglect has inflicted damage to our environment and affected the quality of life. This is best exemplified by the solid wastes generated by wanton use of plastics of various types.

Third, we should not lose control of the technosphere, which is gradually acquiring a life of its own (Ialenti 2020). Booby traps are already emerging such as the overshadowing of refereed journal articles by blogs, the threat of displacement of labor by automation, and, as cited by Johnson et al. (2012), the possible abuses that could result from the application of artificial intelligence.

Lastly, the antiscience movement will certainly affect the application of the rigor of science to support human flourishing and not the collapse of societies. It is our duty to build the intellectual infrastructure that will live beyond anyproduct of the technosphere.