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Leveraging new technologies' impact through technology assessments

Note by the UNCTAD secretariat

Summary

Technology assessment is a problem-oriented process that examines the opportunities and risks as well as the societal effects when a technology is introduced, extended or modified. Technology assessment is therefore an important tool to inform policymakers, to encourage public dialogues about technology and development and to help frame supportive policies to minimize risks and maximize benefits. Some key challenges confronting developing countries in this area are presented in this note, as are several options to address them. The note also contains suggestions of some issues for a policy dialogue by the members of the Investment, Enterprise and Development Commission.

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I. Introduction

1. Science, technology and innovation play an important role in addressing development challenges and achieving the Sustainable Development Goals. However, the potential impacts of new technologies on the economy, society and the environment are often unclear. In fact, technological innovation might have both positive and negative consequences for different people and in different areas of application, and these can also change over time.[1] For example, artificial intelligence in agriculture can enable the precise application of fertilizers and other chemical inputs, but it can also lead to a loss of jobs due to advances in agricultural robotics. The rapid nature of technological change in recent years opens the possibility of the cascading effects of adopting various new technologies across countries that may not be prepared to harness the potential development benefits and address the potential negative effects that they may bring.

2. Robust mechanisms at the national level are therefore essential to effectively evaluate the potential effects of new technologies and to harness their full potential and manage their risks. Technology assessment is a tool that countries can use to evaluate the possible impacts of adopting emerging technologies. However, most developing countries lack experience with technology assessment. It is therefore important to build capacity in technology assessment in developing countries. This is particularly true for technologies in high priority sectors and those that are important for sustainable development. In this note, some considerations are presented regarding technology assessment, particularly concerning the design and implementation of technology assessment exercises that policymakers in developing countries may include in their plans to strengthen their science, technology and innovation frameworks. The role of international cooperation in strengthening technology assessment capacity is also considered, on the basis of a pilot UNCTAD project on technology assessment in the energy and agricultural sectors in selected African countries.

II. Technology assessment to harness science, technology and innovation for development

3. Technology assessment is an interdisciplinary methodology that assesses the opportunities and risks of emerging technologies. The origin of technology assessment is closely linked with the emergence of general-purpose technologies in the 1960s and the response by policymakers to act upon a reliable source of information on the potential benefits and risks of new technologies. The Congressional Office of Technology Assessment of the United States of America was established in 1974 on the premise that the federal branch needed expertise on science, technology and innovation.[2] In the decades that followed, the use of technology assessment proliferated among other developed countries.

4. In the past few years, technology assessments have been increasingly used to address multidisciplinary topics, such as the impact of genetically modified organisms and farming,[3] the economic and societal effects of online platforms,[4] blockchain-based solutions

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[1] Acemoglu D and Restrepo P, 2019, Automation and new tasks: How technology displaces and reinstates labor, *Journal of Economic Perspectives*, 33(2):3–30.

[2] See United States of America, Library of Congress, The Congressional Office of Technology Assessment (OTA) Legacy, Web archive, available at https://www.loc.gov/item/lcwaN0004612/ (accessed 2 September 2022).

[3] Pimbert M, 2007, A citizens' space for democratic deliberation on [genetically modified organisms] GMOs and the future of farming in Mali, Briefing, International Institute for Environment and Development.

[4] Gawer A and Srnicek N, 2021, Online platforms: Economic and societal effects, European Parliament, Panel for the Future of Science and Technology (Scientific and Technological Option Assessment).

to food supply,[5] the benefits and challenges of machine learning in drug development[6] and the role of technology transfer in wind farming,[7] to name a few.

5. Over the years, technology assessment has developed as a discipline that shifted from having only an advisory role related to economic policy based on analytical methods to a broader field pursuing multiple goals and applying a diverse set of methods, including communication and dialogue techniques. Technology assessment has become an interactive, communicative and scientific methodology that has a threefold objective:

(a) Assess the benefits and risks of emerging technologies;

(b) Contribute to the formation of public and political opinion on the social aspects of science, technology and innovation, including their opportunities and challenges;

(c) Supply effective, pragmatic and sustainable options for policy action.

6. By undertaking technology assessment, policymakers become better equipped to identify priorities and improve the cost-effectiveness, long-term impact and environmental sustainability of technology policies and investments, while being able to take into account socioeconomic and environmental implications. Technology assessment has become a crucial element in the toolbox of policymakers to evaluate the socioeconomic and environmental implications of introducing technologies for Sustainable Development Goal-related challenges.

III. The technology assessment process

7. The processes and methods of technology assessment have evolved over time. They are most commonly defined by the development of interactive processes that bring together science, technology and innovation, society and policy. The interplay between these three elements (technology, society and policy) may enable important benefits in terms of ensuring appropriate directionality for the deployment of frontier technologies in developing countries, as noted in chapter IV of the UNCTAD *Technology and Innovation Report 2021*.[8] In order to tailor technology assessment for the context of developing countries, UNCTAD has developed a methodology that is based on participative technology assessment approaches to achieve inclusive stakeholder engagement in the process. The approach taken incorporates citizen and decision-maker participation with technical expertise and is aimed at informing policymakers dealing with science, technology and innovation policies and strategies and those working on energy and agricultural policies.

8. The linking of technology assessment to policy processes and development policies related to science, technology and innovation, agriculture and energy is a key goal of the methodology. There may be linkages to other key policy areas, such as industrial policy, education, trade, foreign direct investment and environmental policy, which can have important linkages to science, technology and innovation policy. These linkages can be direct or more indirect. In Europe, technology assessment is often undertaken at the direct request of a country's parliament for the purpose of providing policy advice. In the United States of America, technology assessment was originally to advise the country's congress on the impact of technologies. The link to policy in these cases is (or, in the United States, was) direct and technology assessment is undertaken to advise policymakers. In a number of European Union countries, there are specialized agencies that undertake technology assessment. This structuring of technology assessment with direct linkages to policymakers

[5] Köhler S and Pizzol M, 2020, Technology assessment of blockchain-based technologies in the food supply chain. *Journal of Cleaner Production*, vol. 269, 122193.

[6] United States of America, Government Accountability Office, 2019, *Technology Assessment, Artificial Intelligence in Health Care: Benefits and Challenges of Machine Learning in Drug Development*, GAO Publication No. 20-215SP, Washington, D.C.

[7] Chen Y, 2018, Comparing North–South technology transfer and South–South technology transfer: The technology transfer impact of Ethiopian wind farms, *Energy Policy*, 116:1–9.

[8] UNCTAD, 2021, *Technology and Innovation Report 2021: Catching Technological Waves – Innovation with Equity* (United Nations publication, Sales No. E.21.II.D.8, Geneva).

creates a high potential for policy impact in the country concerned. With the profound impacts that are being experienced from the adoption of some new and emerging technologies, the link to policymakers facilitates policy advice and policy action where action is seen by policymakers as being warranted. This might be, for example, in terms of measures to support technology adoption or to establish certain regulations in order to address potential undesirable uses or impacts from the adoption of a technology.

9. The diffusion of technology assessment in developing countries remains very limited. There have been some technology assessment exercises (or exercises that are close in nature to technology assessment) in a few developing countries, which tend to have been implemented by public bodies or by universities. However, in many developing countries, capacity on science, technology and innovation in general is relatively weak, and specific capacity for technology assessment is extremely limited or non-existent. To respond to this lack of capacity, the technology assessment methodology that has been developed by UNCTAD adapts existing experiences of technology assessment to the context of developing countries. The implementation of this methodology in several pilot countries (see chapter V below) is expected to provide insights on the approaches to technology assessment that may be more effective for the science, technology and innovation policymaking needs of developing countries.

10. The UNCTAD methodology for technology assessment is based on the notion that building linkages between policymakers and the technology assessment expertise that may exist (or be developed) in a country is essential to ensure that technology assessment exercises provide policy-relevant advice that is actually usable. The aim is to avoid the assessment becoming only a technical exercise undertaken on a purely ad hoc basis with no connection to science, technology and innovation institutions, policymakers or policy processes, in which case the assessments could become a largely academic exercise with little policy impact.

11. As shown in the figure, the UNCTAD methodology for technology assessment is composed of seven steps:

(a) Establishing a governance structure for the technology assessment exercise. This structure has vital functions to perform, including ensuring national ownership for the project, taking strategic decisions, evaluating outputs and providing inclusiveness. UNCTAD suggests putting in place both a steering committee and an expert group. The steering committee consists of representatives of the project's sponsor (for example, the relevant line ministry or prime minister's office) and independent external technology assessment experts and has responsibility for the overall management of the technology assessment. The expert group is composed of an interdisciplinary team of experts who will prepare and accompany the analytical process from the beginning to the end.

(b) Priority-setting, determining which specific technologies are sufficiently relevant for a country and its sustainable development to be put on the agenda and assigned high priority. The steering committee plays a central role in priority-setting, alongside other stakeholders, such as firms and entrepreneurs, and may be based on demand-side considerations or driven by the technology supply side or based on a combination of both.

(c) Framing the questions that the technology assessment should address. At this stage, the societal, political and scientific domains related to the selected list of technologies are considered in order to define an exact problem to be targeted by the technology assessment, and to identify a suitable project design.

(d) Setting the goals. The various concrete goals of a technology assessment are disentangled and defined along three pillars: raising knowledge (about technical and scientific issues, but also social and policy ones), forming attitudes (this includes aspects such as agenda-setting or mediating among stakeholders) and initializing action (for example, proposing new regulation/legislation or introducing new decision-making processes).

(e) Project implementation, which entails the gathering, analysing and synthesizing of evidence about the technology in question, its core features, risks and opportunities in the local context, will play a significant role in any technology assessment

process around new and emerging technologies by using a plurality of methods and tools. The involvement of stakeholders, mapping of their interests and assessments against given social norms and values is an important second step. Drawing on advice from the expert group, the steering committee will select which techniques would be used to develop required instruments and models. Finally, by utilizing a variety of interactive methods, the aim of this exercise is to validate these findings and collect recommendations in relation to the selected technologies.

(f)   Quality control, which ensures that the overall results achieved under each technology assessment exercise are of high scientific quality by including, for instance, a multidisciplinary peer review or an external expert discussion. Similarly, additional measures are to be put in place so that the technology assessment process achieves its goals from different stakeholder perspectives.

(g)   Reporting, which can comprise a broad array of outputs, including technology assessment reports, policy briefs and technology assessment recommendations. These outputs highlight various policy challenges and policy options found by the assessment.

Steps in a technology assessment process
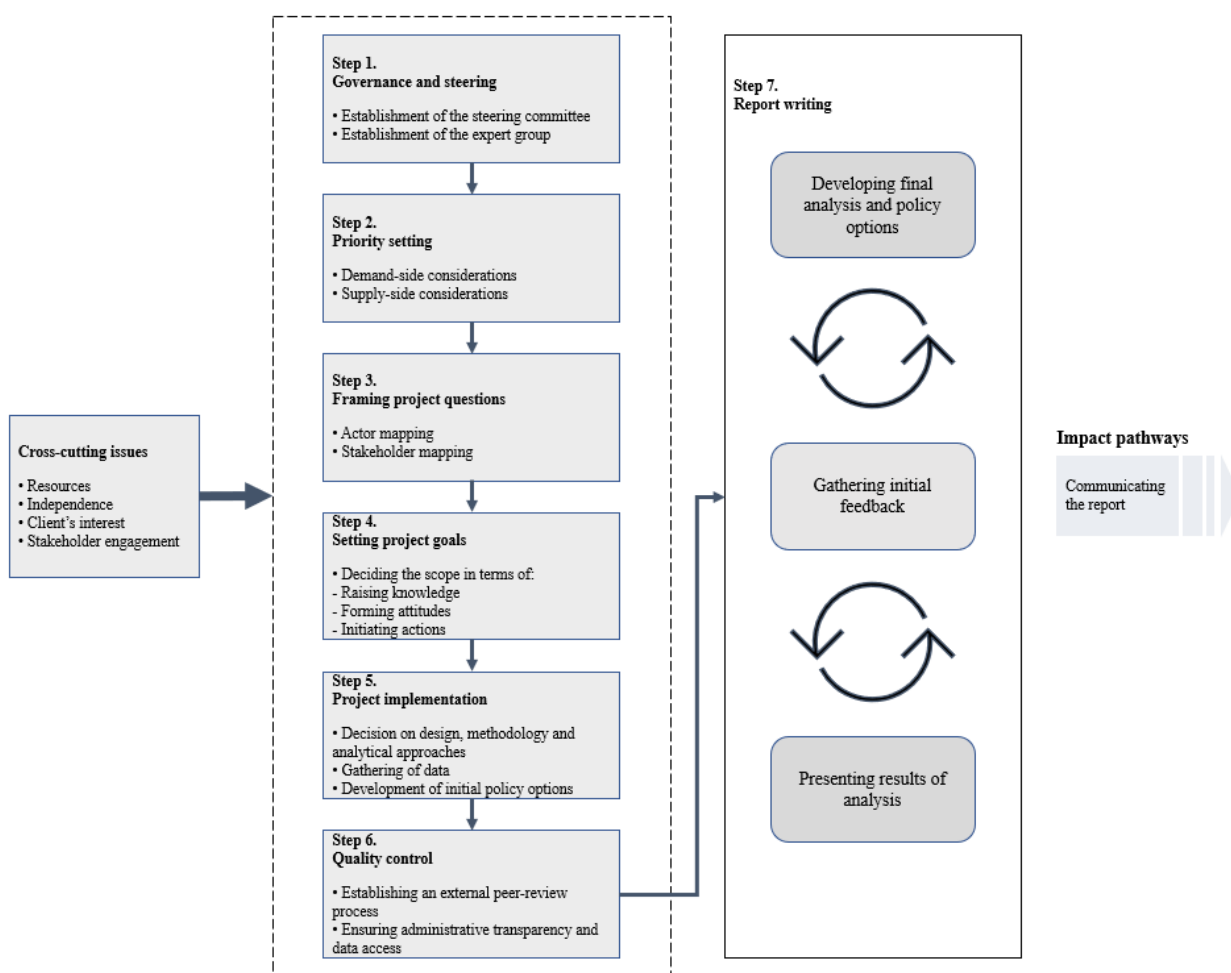
12.   Throughout the process, and particularly during the implementation phase, different techniques are employed to achieve the various goals of technology assessment. The resulting methodological toolkit includes a wide array of potential techniques, such as:

(a)   Scientific methods, such as expert discussions, Delphi method and modelling or simulations;

(b)   Interactive methods, such as consensus conferences, citizens' juries and scenario workshops;

(c)   Communication tools, such as newsletters, articles in the press and video presentations.

13.   These techniques enable expert analysis and broad multi-stakeholder inputs and seeking their inclusion in the policy and strategy discussions and frameworks of a given country for the use of science, technology and innovation in support of the Sustainable Development Goals.

IV.   The importance of international cooperation

14.   As noted above, the use of technology assessment as a science, technology and innovation policy tool has been widespread in numerous developed countries for several decades. Offices performing this type of analyses have been institutionally located in parliaments, and deliberations about new technologies and innovations have been driven by democratic traditions and participatory processes that allow all stakeholders to express their views and opinions safely. In many developed countries, technology assessment is bolstered by robust national systems of innovation, which host a relatively large number of scientific and technical experts who can contribute to technology assessment exercises.

15.   In comparison, the experience of technology assessment in most of the developing world remains limited. Given the many other claims on the limited resources available for science, technology and innovation in the majority of developing countries, technology assessment tends to rank low in the priorities of their policymakers. At the same time, their national systems of innovation are generally not sufficiently advanced to offer the required knowledge, and they may be less able to count on inclusive processes that typically engage different interest groups as stakeholders. UNCTAD interaction with members States interested in technology assessment in the context of the development of the methodology and pilot project described in chapter V confirms that while the understanding of the benefits of technology assessment for more effective policymaking are increasingly understood, developing countries are also keenly aware of the need for significant capacity-building before technology assessment can become a standard component of their policymaking process.

16.   International cooperation can play a major role in supporting developing countries to pursue their interest in undertaking technology assessments and building national capacity in technology assessment. In addition to mobilizing financial resources and expertise, international cooperation can help provide guidance on adapting technology assessment practices that have been developed in countries with a strong technology assessment tradition for developing countries, taking on board good practices developed through experience. UNCTAD has a long tradition of science, technology and innovation policy support to developing countries and can help in bringing international experience to interested developing countries through collaboration with international technology assessment experts and science, technology and innovation practitioners. This type of international cooperation can play an important role by:

(a)   Focusing on the issue of recent and emerging technologies that could be crucial for developing countries;

(b)   Encouraging discussion of economic, social and environmental impacts of the selected technologies;

(c)   Supporting the efforts of the national public sector to access and master some priority technologies for the country in question.

17.   In a virtuous circle, once technology assessment capacity is more widely available in developing countries and technology assessment exercises more regularly undertaken, their outcome could provide helpful inputs to the design of international cooperation programmes in the area of science, technology and innovation, by directing cooperation

resources to those sectors and specific technologies and deployment strategies with a higher likelihood of positive social, environmental and economic impact.

V. UNCTAD activities to build technology assessment capacity in developing countries

18.   In order to boost expertise on technology assessment in developing countries, UNCTAD began a programme of support on technology assessment in 2021. This three-year long project includes the development of the UNCTAD methodology, the piloting of assessments in three collaborating countries (Seychelles, South Africa and Zambia), follow-up to the assessments in each country and learning from the pilots. The project is focused on technologies applied in agriculture and/or energy. Based on the experience of the three countries, lessons from the implementation of the UNCTAD methodology will be documented and used to refine it. The results will be shared with other developing countries before the end of the project (including through the UNCTAD intergovernmental machinery and the United Nations Commission on Science and Technology for Development) so that other developing countries can benefit from the learning from these pilot exercises and consider whether they might wish to undertake an assessment exercise.

19.   The project will deploy the UNCTAD technology assessment methodology for assessing the socioeconomic and environmental implications of the adoption of technologies in the agriculture and energy sectors. Through a participatory process involving a wide range of stakeholders, countries will build national capacity to assess the implications of adopting a particular technology and identify policy tools that harness the benefits of technologies, as well as mitigate their potentially negative effects. In the mid- to long-term, countries can develop institutional capacities to continuously scan, monitor and assess the impacts of technologies as they unfold. As part of the technology assessment methodology, countries may consider engaging in foresight methods that help them identify new and emerging technologies, along with science, technology and innovation policy instruments oriented towards sustainable development and the Sustainable Development Goals.[9]

20.   The UNCTAD approach to this programme advocates for a broadening out of inputs to technology assessment and an opening up of political debate about the implications of technological change, going beyond purely technical or accounting exercises.[10] In this sense, technology assessment can catalyse a broader social, political and inter-institutional debate on the divergent views of pros, cons and associated uncertainties across alternative directions for interlinked technological and socio-technical change.

21.   Technology assessments are feeding into policymaking in the line ministries for science, technology and innovation, agricultural and energy policies, related national parliamentary debates and donor discussions. Also, this methodology has linkages to technology needs assessment as well as to science, technology and innovation policy. While technology needs assessments have been used to identify, prioritize and diffuse selected technologies for national priorities (especially for climate change mitigation and adaptation), technology assessment focuses on the impacts and possible systemic and unintended effects of technologies. In domains like energy and agriculture, the innovative use of technology assessment can assist in identifying priorities and helping improve the cost-effectiveness, long-term impact and environmental sustainability of technology policies and investments. In this context, technology assessment can be a complementary and mutually reinforcing process for science, technology and innovation policy (STIP) reviews at the national level, as well as science, technology and innovation for Sustainable Development Goal road maps.

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[9] UNCTAD, 2019, *A Framework for Science, Technology and Innovation Policy Reviews*, UNCTAD/DTL/STICT/2019/4, Geneva.

[10] Ely A, van Zwanenberg P and Stirling A, 2014, Broadening out and opening up technology assessment: Approaches to enhance international development, coordination and democratization, *Research Policy*, 43(3):505–518.

VI.   Questions for consideration by the Commission

22.   Against this background, the Investment, Enterprise and Development Commission may wish to explore in its policy dialogue several questions related to the policy responses at all levels that can be relevant to take current efforts to harness science, technology and innovation for the Sustainable Development Goals to the necessary level:

(a)   How can technology assessment help address the concerns of member States in the light of the rapid development of emerging technologies and their impacts on countries adopting them?

(b)   What are the priorities of member States in terms of the development of their technology assessment capacities?

(c)   What is the experience of member States with undertaking technology assessment in their national context? What key challenges, benefits and practical lessons can be identified?

(d)   How can international collaboration help to build technology assessment capacity in developing countries so that they can prepare for adopting emerging technologies?

(e)   How can UNCTAD and other international organizations help to support developing countries in building technology assessment capacity and capacity in closely related areas of science, technology and innovation?