thing is to find a way to develop a consensus among stakeholders about what to gauge and how to do this. The EU expert group did not offer a general prioritised list of indicators but instead suggested an exemplary way that can be followed by stakeholders (regional actors, universities and research institutes, civil society organisations, funding agencies, etc.) to tailor the indicators according to their own needs, goals and concerns. The group found at least around 100 possible indicators in the eight categories! When we looked at the level of individual RRI criteria, such as public education, gender equality or sustainability, we noted that each of these is subject to its own policy development, policy action and monitoring. To successfully implement and develop RRI as a cross-cutting principle of research and innovation policy, a limited set of indicators should be selected that should include indicators for all eight RRI criteria and that should exhibit a balance between process and outcome indicators. Rather than the emphasis being on ‘hard facts’, chosen because they are easy to quantify, to be fed into an illusory command-and-control mode of governance, it should be on information that is helpful in collaborative modes of governance, developing trust, best practices and mutual institutional change.

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Indicators in Technology Assessment

Passive Choices or Reflected Options?

Nuno Boavida and Stefan Böschen

Abstract

There is a lack of research on indicators in TA studies. But, there are several reasons supporting the need to address this omission: indicators are cornerstones of many TA studies, revealing the scope and quality of the problem addressed. They are not normatively neutral instruments for analysing problems, but they can frame problems and strategies for the solution of problems. They need to be transparent and thoughtfully selected to open alternatives and prevent unintended controversies; they require substantial reflection because conditions for their use may change significantly, and finally they can provide valid insights for TA about the policy process. Furthermore, this paper offers a heuristic model for analysing knowledge production within TA studies. This is done to improve the analysis of complex problems and structuring options for democratic decision-making. The model proposes a detailed explanation of the complete selection of indicators using transparent criteria and analysing the observables used or the ones which should be used or the ones not yet known. Finally, this paper provides insights into the discussion of the panel organized while addressing the question as to how we can acquire deeper and more comprehensive knowledge leading TA professionals to reflect on options in their studies.[1]

Introduction

Technology assessment (TA) deals with complex technology problems. Usually, a TA study includes a set of indicators to decipher such problems. The selection of indicators is a sensitive and critical procedure. On the one hand, indicators are used by actors in the field being analysed, who frame the problem in a way that corresponds to their cultural and normative background as well as to their economic and political interests. In these cases, the selection of indicators can entail options that are not neutral, trivial or even conscious, creating an implicit and sometimes controversial space for “indicator politics”. This can be easily underpinned by looking at the debates about the risks of smoking or the climate change debate (cf. Proctor/Schiebinger 2008). On the other hand, there are also TA experts using indicators to describe the problem and to evaluate the options for acting and decision making. As TA experts operate in a “relative distance" (Gloede 1992, p. 324) to the fields being analysed, they normally have to rely on the indicators used by the actors, but also to offer a critical perspective on these indicators and to evaluate whether they are appropriate or not. Furthermore, the set of indicators selected to decipher a TA problem also varies with the evolution of the debates. For example, the debate about risk regulation of chemicals changed from the 2000s as it was no longer only oriented towards the damage (with indicators of toxicity or carcinogenicity), but also to the so-called hazard indicators (with indicators of persistency or bioaccumulation potential) (cf. Böschen 2014, p. 42). Thus, the selection and evolution of indicators in TA studies is a sensitive and critical procedure that can reveal the scope and quality of the problems being addressed.

Therefore, indicators are to be seen as a cornerstone of any TA study, where they represent effect-related aspects of the problem. This centrality suggests that practitioners should reflect not only about their use but also about the non-use of indicators. However, this analysis is unfortunately not routinely done. Against this background, we would like to put the thesis forward that TA has to shift from passive choices to reflected options in the use of indicators. In fact, TA has to reflect more thoroughly on the logics of the construction and application of indicators to improve its own quality of expertise. This thesis will be presented in three steps of argumentation. First, we want to review some general challenges with regard to the use of indicators, mostly based on innovation studies. Second, we want to describe the challenges in the use of indicators in TA studies. Third, we offer a heuristic model to reflect on the construction and application of indicators in TA, relating it to the comments made in a recent debate about indicators. This model overcomes the existing limitations by aligning the non-scrutinizing use of indicators in two ways: first by improving the analysis of complex problems in a scientific way, and second by providing a more useful structuring of options for democratic decision-making.

Some General Challenges while Using Indicators

There are some problems that can arise from the use of indicators in general as well as some significant challenges specific to TA activities. Let us first identify the problems associated with the general use of indicators, before proceeding to the challenges they present in TA activities. The literature reveals three main problems related to the general use of indicators.

One of the main problems with indicators is related to the variety found in their definitions and construction. The variety is significantly contingent on the topic and on the objective of the study. For example, Heink and Kowarik (2010) revealed that other authors in the same specific field of ecology and environment had often used different definitions and different indicators. The variations found in the definition of ecology and environmental indicators were significantly dependent on the topic under observation, the objective and the intended final user (e.g. politicians, researchers, companies, experts, general public, and media). The authors also pointed out that none of the available definitions of indicators could cover the complete concepts the term can have within ecology and the environmental arena. Thus, the definition of indicators and the indicators themselves vary significantly with the topic and objective of each study. Another aspect with regard to these, so to say, technical challenges in indicator

constructions consists of problems associated with the aggregation of indicators in composites or indexes. In the science, technology and innovation field, there is academic discussion about the purpose and methodologies used to gather data and build these types of indicators (Godin 2008; Nardo et al. 2008; Grupp/Mogee 2004; Barré 2004). Grupp and Schubert (2010) argued that some composite indicators in innovation were not subject to extensive research and may present problems of confidence, comparability and overlapping. Nevertheless, scoreboards or composite indicators are often preferred by policy-makers, as they can function as strategic instruments to influence changes in policy and for communication.

The second type of problem relates to the general effects of the use of indicators. In brief, the use of indicators can produce general effects (e.g. fatigue, resistance, pressures, clashes), be subject to political influence, have an impact on users, and be a straitjacket to parts of society. Furthermore, the systematic use of indicators can impose a moral and an ethical behaviour through the silent assimilation of their implicit values and duties into society (Merry 2011). Some examples of these effects can be found in the systematic use of, for example, innovation rankings, school rankings, new public management prescriptions, and the European Commission's excessive deficit procedure[2] (cf. Dahler-Larsen 2013). In sum, innovation indicators can present dangers to societal coordination through their increased complexity, ambivalence of interpretation, de-contextualisation; they may present problems of confidence, comparability and overlap; and they may lead to 'shaming and blaming' of countries and to media oversimplification (Feller-Länzlinger et al. 2010; Grupp/Schubert 2010; Nardo et al. 2008; Grupp/Mogee 2004).

The third and last main problem is related to the potential for deception that exists in the use of indicators. This point becomes obvious when looking at the use of indicators as an evaluation method, e.g. for measuring the impact of research, innovation funding and policies. In fact, Kuhlmann (2003, pp. 137-9) warned against using indicators alone to perform these evaluations because they are not compatible with the tendency to pursue complex political goals. In fact, the evaluations should combine various social science methods with indicators. There are many examples where an incautious observation of reality led, through indicators, to misconception of phenomena. C. Freeman (1995) provided two examples of how quantitative indicators could not explain changes in innovation systems. In a first example, the author showed that comparisons of research and development (R&D) indicators were an inadequate method for explaining the Japanese institutional and technical changes in the 1970s and 1980s. In his opinion, these changes needed a qualitative description because the Japanese quantitative analysis erroneously identified a concentration in the fastest growing civil industries (e.g. electronics), with patent statistics showing a leading role at the world level. However, these measures of research and inventiveness did not explain how these activities led to higher quality new products and processes, to shorter lead times and to more rapid diffusion of different types of technology such as robotics. The second example came from the other side of the former iron curtain. According to Freeman, the former Soviet Union's commitment to greater R&D did not in itself guarantee successful innovation, diffusion and productivity gains, as the fall of the Berlin wall would prove.

Challenges Posed by TA Indicators: Some Basic Arguments

The use of indicators in TA activities presents challenges primarily related to selected epistemological questions. While using indicators some fundamental questions have to be addressed. An indicator is a tool to know something about a selected aspect of the social or natural environment. Therefore, while using a specific indicator one focuses one's attention on a selected aspect of the environment and ignores others. This leads to questions as to whether the existing indicators are contradictory or not, what can be known about a problem by combing all of the existing indicators, and what the limits of this knowledge are. But another part of the story also has to be taken into account. This is how indicators are used in the policy arena and what this means for TA as expertise. On a first sight a few challenges can be described, leading us to the necessity of having a heuristic model for reflecting about the use of indicators.

First, reflection about indicators is central to TA practitioners because problem-centred studies frequently rely on indicators to address relevant societal questions about technology (Barré 2001). For example, in a TA study about the potential and the impact of cloud computing services, Leimbach et al. (2014) employed indicators of the type of use in cloud computing services and of the type of cloud services to understand and explain the adoption and usage patterns of companies and consumers. Thus, indicators are frequently used as a conceptual tool for analysing real-world technological problems.

Second, indicators cannot be seen as a normative neutral instrument for analysing problems. Although indicators are tools for describing and analysing a problem methodically, their selection is everything but normatively neutral. It makes an important difference whether one looks at the CO2 footprint of a product or at the whole chain of different risk factors associated with a technology. Furthermore, a TA position strongly oriented towards the precautionary principle will also be expressed in the utilization of hazard indicators because they address possible harm and not only concrete damage (cf. Böschen 2014). Therefore, the selection of indicators is not normatively neutral and is driven by specific criteria used by the actors proposing a focused description of a problem.

Third, the description of complex problems and the strategies for their solution are heavily influenced by the use of indicators. For example, the use of an indicator of 'security of livelihood' in a sustainability problem introduces a specific description of a selected problem which is in this way placed as a key problem against which strategies for its solution are to be defined (cp. with regard to climate science: Petersen 2012). In another example, use of the indicator of toxicity as a central problem concerning the regulation of chemicals introduces both a specific description of the problem and a strategy to deal with it (cf. Böschen 2014). The use of indicators to provide a description and the classification of safety or precautionary strategies are interlinked. In many debates, the availability of specific problem-solving strategies organizes the problem context that is addressed through indicators (e.g. Garrelts/Flitner 2011).

Fourth, the selection of indicators needs to be as transparent and thoughtful as possible. In fact, the selection may not only lead to opening new alternative technology options, but may also trigger significant controversies between TA practitioners and stakeholders that are used to a

limited set of indicators. In fact, the group of stakeholders may be accustomed to framing the problem by using indicators according to their cultural norms and/or their economic-political interests. For example, the debate about the risks posed by nuclear power plants shifted in the moment the indicator of climate neutrality came in, because nuclear fission previously seemed to be a 'green technology'. In this context, the selection of a 'new' indicator can trigger controversy, because those associated with nuclear interests may tend to dismiss an indicator of climate neutrality linked to the specific risks posed by the production and storage of nuclear waste (as in the just published Eco-Modernist Manifesto; cf. Ecomodernism.org 2015). Thus, the selection procedure of indicators needs transparency and reflection in order to both open policy alternatives and reduce the room for unnecessary controversies.

Fifth, the selection of indicators in TA requires substantial reflection also because the selection criteria may differ significantly in different fields of work. For example, in a mature topic such as pharmaceutical policy there is a significant amount of accessible data, the political context is known, and the stakeholders and the policy impact are relatively easy to identify, although issues may continue (cf. Demortain 2011). In a field of emerging technology such as nanotechnology or synthetic biology, however, there is less information available, the field has a different and evolving political context, and it can involve unspecified stakeholders or consequences (cf. Torgersen 2009). Moreover, the use of indicators in established fields has to be continuously reflected as there might be changes in methodology or new empirical test settings relevant for uncovering possible harm or damage. Therefore, the transference of indicators in established fields to a new or different technology needs reflection, as the conditions can change significantly and/or changes in methodology or new relevant empirical test settings might be necessary.

Sixth and last, an understanding of how indicators are involved in policy-making can help TA practitioners to better adapt their analysis to the specific needs of policy processes. In fact, insights about the policy process can help to differentiate from scientific and business processes, to develop public participation practices and to improve scientific communication of findings. In this process indicators play a key role as they are the cornerstones of the problem description and therefore of the problem which is seen to be addressed politically (cf. Petersen 2012). Consequently, it is decisive to make the selection of the indicators used to describe a problem transparent as well as that of the ones which are not selected, because the selection heavily influences the description of the problem and the process of finding a solution. In this way, critical reflection of the use and non-use of indicators itself opens up a political space of selecting the appropriate description of a problem in relation to normative grounds.

Furthermore, against the background of the specific features of TA in policy as well as in politics, the importance of such a critical reflection on indicators for TA studies becomes significant. According to Bernard Reber (2006), TA in a policy analysis perspective has its own limitations, mostly related to the resources needed to facilitate the interaction between TA researchers and policy makers, as well as any time restriction on the collection, consolidation, and dissemination of results. It is often the case that the scientific staff of a TA organization lacks experience concerning the policy culture, although some staff members may lead double career paths and are trained both in the hard sciences and in policy-making, according to the author. In addition, scientific analysis and political action are also based on significantly different logics. Scientific knowledge is likely to be strategically used (or ignored) opportunistically in the negotiation of different policy-making interests. Policy processes also face significant demands for justification, especially in the media, which insist on being told the reasons after or before political actions, according to the author. Therefore, it is important to link these two different spheres of action. TA, and in particular parliamentary TA, has the comparative advantage of demanding deeper justifications for policies options and providing a structure where normative and scientific issues are granted a clearer voice (Reber 2006).

But, a transparent system for structuring knowledge is needed for this advantage to be visible. This is why a clear distinction has to be drawn between general problem descriptions (which are offered by indicators) and both their empirical foundation as well as their normative consequences. To proceed in this way, we propose to use a model built on three categories: indicators, criteria and observables (cf. Böschen 2014).

From Passive Choices to Reflected Options?

These three qualifiers of knowledge make it possible to reflect on the construction and use of indicators. They can be defined as follows. Criteria evaluate indicators against the background of the main cultural values or interests and can be related to the indicators' policy relevance, utility, analytical soundness and measurability, and other (un)conscious factors. Indicators represent an effect-related aspect of a problem which should be considered or solved. And finally, observables concretize indicators by providing specified methods for empirical observations or test strategies. Why should we proceed in this way? Our thesis is that this scheme allows clarifying the layers to which the different arguments or examples of empirical evidences are related. Therefore, it enables us to classify any sort of knowledge with respect to the description of a problem. Moreover, it offers an insight into the values seen as relevant for constructing the respective problem horizon.

What does this mean with regard to TA studies in a practical sense? With regard to the construction of TA expertise, any study needs a clear formulation of the initial problem. But, this formulation changes if one uses such a methodological model. This heuristic model should allow a transparent selection of indicators, their related criteria and the observables that describe the problem as a whole. Therefore, TA exercises should include space to reflect about the inclusion and the non-inclusion of certain indicators – which allows insights into the related criteria but also perhaps into the limitations of the available data. In addition and based on this reflection on strategies for using indicator, the analysis phase should include a reflexive process about the social, cultural and political consequences of the selection of indicators, before technology options are suggested and recommendations elaborated.

During the 2015 PACITA Conference, which is reported in this book, we organized a panel on "Indicators in Technology Assessment – Passive Choices or Reflected Options?". The presentations were mostly located at the methodological level. In fact, three contributions intended to shed light on (1) how to measure societal impact on innovation activities (by Rainer Frietsch of the Fraunhofer ISI); (2) how to measure the effects of the introduction of requirements related to responsible innovation in the Horizon 2020 programme (by Jack Spaapen of the Dutch Academy of Arts and Sciences); and (3) how to shift the focus of indicators from the effects of emerging technologies to the triggers of their hazards to enable them to serve as early indicators of the future impact, such as production quantity, persistence and bio-accumulative potential (quality), release into the environment, ability to proliferate (e.g. genetically modified organisms) and mobility of nanoparticles in organisms and in the environment (by Arnim von Gleich and Bernd Giese of the University of Bremen). In a different way a fourth presentation designed a frame to create an indicator of integrity as a way of rehabilitating science and avoiding alienation by identifying secondary interests, such as ideology, administration, commerce or utility (by Ole Döring, Horst-Görtz-Institute, SIGENET Health, Charité).

Starting with the fourth presentation (cf. Döring this volume), the main argument was not only to establish integrity as an indicator, but also to outline the key aspects of such an indicator. These are mainly based on specific procedural prerequisites. For example, as "the typical complexity in matters of TA requires best utilization of academic and moral resources", an "open, explorative and discursive trans-disciplinary program" is needed. Moreover, he argues for a "targeted employment of indicators", which is seen in a "well considered collaboration of quality and empirical-metrical modes", and a "Pro-active definition of quality", i.e. one which takes a look on "science as process". These arguments are underpinning the need for a heuristic model, as we offered here, to support a process of science that is transparent with regard to the main perspectives (condensed in indicators), the main sources of empirical data (stylized as observables) and the values used (bundled in criteria) as the sine qua non step in such an analysis.

With regard to the other presentations, the interplay between the three categories of our heuristic model and the importance of this way of understanding was also observable. Rainer Frietsch's question about the measurability of societal impact on innovation focuses directly on the centre of puzzling questions about the problems of constructing an indicator under circumstances of difficult boundary conditions of data availability. As the aim of measuring the societal impact on innovation processes is to compare the innovation environment in different countries, the observables of such an indicator have to be constructed in a way that the data related to the observables selected are available in all the countries included in the study.

Arnim von Gleich and Bernd Giese showed how the two indicators for the early concerns "intensity of intervention" and "depth of intervention" can be used for precautionary measures. Here, the political decision-making process was of main interest. Specifically, as these indicators themselves are composed of different sub-indicators, this presentation shows how challenging in detail such an analysis has to be, while also having a clear strategy for defining and sorting the knowledge elements.

Finally, the study by Jack Spaapen offers an insight into the challenges of how to transform a political guiding principle (in this case, the one of 'responsible research and innovation' of the European Commission) into a valuable set of indicators. The construction of indicators themselves has to correspond to the main ideas of such a guiding principle, i.e. transparency and responsibility, while also serving as criteria. Therefore, a social process has to be designed that allows support to be provided to the scientists and administrators involved in each project and for feasible indicators to be constructed. One conclusion is that if the relationship between criteria and indicators is unclear, a procedural approach is needed to reflect upon the normative boundary conditions and their relationship to the demands concerning what has to be measured and whether the facts taken in to account are feasible with regard to the criteria.

This short analysis offers an insight into how the notion of passive choices in the use of indicators can be transformed into reflected options. This procedure is challenging as not only epistemological questions have to addressed, but also questions of designing suitable processes for constructing and selecting indicators and their related normative qualifiers (criteria) as well as empirical qualifiers (observables).

Conclusion

This paper argues that the use of indicators in TA needs further inquiry. In fact, the selection and evolution of indicators can reveal the scope and the quality of the problem addressed. We identify three main problems associated with the use of general indicators: the variety of definitions and constructions, the general effects of their use, and their potential for deception. We then advanced six main arguments to deepen this field of TA research: indicators are cornerstones of many TA studies; they are not normatively neutral instruments for analysing problems; they can frame problems and the strategies for solving problems; they need to be transparent and thoughtfully selected to open alternatives and prevent unintended controversies; they require substantial reflection because the conditions for their use may change significantly; and they can provide TA valid insights about the policy process. Furthermore, the gap in the literature of indicators for TA needs to be addressed with research on the procedures for selecting indicators and more debates about different experiences. The heuristic model offered here provides instruction for analysing knowledge production within TA studies, improving the analysis of complex problems in a scientific way, and structuring options for democratic decision-making. The model proposes the need for TA practitioners to explain their complete process of selecting indicators by using transparent criteria and analysing the observables that exist. The model also advises detailed transparency in cases where observables do not exist and cannot be obtained or overlap. In addition, the panel organized to discuss this topic at the PACITA conference confirmed the need for more contributions in order to debate the use of indicators in TA. Participants stressed the growing need for more investigations to acquire a deeper and more comprehensive understanding that can lead to reflected options by TA professionals in their work.

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Integrity as an Indicator in Technology Assessment

Towards a Framework to Connect Motivational and Organizational Extensions of Quality Assurance

Ole Döring

Abstract

This article explores the concept of "integrity" as indicator in TA. It proposes a conceptual framework for reducing the dependence on quantitative or formalistic indicators and increasing the significance of qualitative indicators. At the same time, it reports on an ongoing study of governance strategies concerning ethical and quality requirements in biotechnology, in Europe-China interaction, and in health-related research. This comparative analysis has been developed through Sino-European collaboration on the ethics and governance of health and life science-based technologies. This conception connects motivational and organizational extensions of quality assurance, as a professional program for self-cultivation under conditions of adherence-based governance.

Introduction

Technology assessment (TA) is a standardized practice for assessing the ways we construe, use, and relate to technology. A TA model depends on indicators that accommodate the meaning of such a model, that is, its purpose, its theory, and its methodological framework in practice. Can an ethical concept such as "integrity" be presented as an indicator in TA? This article introduces observations from an ongoing study of governance strategies concerning ethical and quality requirements in biotechnology, in Europe-China interrelations, and in health-related research. As part of a comparative and discursive investigation into Chinese/Confucian and European/Kantian conceptual frameworks in ethics that has been developed over two decades and through a series of studies about the ethics and governance of health and life science-based technologies, this emerging conception connects motivational and organizational extensions of quality assurance as a professional program for self-cultivation under conditions of adherence-based governance. It also circumscribes the structure of a research program.