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Assessment of social implications of nanotechnologies in Japan: Application of problem structuring method based on interview surveys and cognitive maps

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ABSTRACT

This paper aims at developing a problem structuring method based on interview surveys of key stakeholders and a well-known visualizing technique, called a "cognitive map." We found that this new method, based on an interactive process with key stakeholders, was able to draw broader and more detailed issues than was previously anticipated. We also found that the proposed method was useful for the analysis of the societal implications of emerging technologies, such as nanotechnologies, which are not easily defined. It is confirmed that the proposed method can clarify common and diversified issues based on the perception of key stakeholders and identify additional stakeholders to be interviewed.

1. Introduction

Research and Development (R&D) of nanotechnologies is being actively carried out all over the world. Paralleling this, researches on the societal implications of nanotechnologies have been implemented especially in the USA and European countries. However, Japan has lagged behind these countries in this area, and currently there are no research projects on ELSI in Japan. (Researches on the societal implications of nanotechnologies are divided into two groups. One is on environment, health and safety (EHS; see [50] for Japan's engagement in this issue). The other is on ethical, legal, and social issues (ELSI).).

In light of this background, this paper aims at studying ELSI based on the concept of *problem structuring*, which is often referred to in public policy and soft operations research. As we will explain later, there are many stakeholders relevant to nanotechnologies, and there are many perspectives on *what the problems are*. Therefore, we set three goals in this paper. First, using the problem structuring method, we will grasp the variance of perceptions on the societal implications of nanotechnologies among stakeholders. Second, based on that, we will identify potential issues which possible TA projects will address. Third, we will identify relevant stakeholders to these issues whom we were unable to recognize before the implementation of the method. These three outputs serve as a basis for building a consensus on what the problems are and what should be accomplished. In this paper, these are implemented as activities in the early phases of technology assessment.

We do not intend to propose a method that can predict societal implications of a technology. Schnaars et al. [45] investigated the results of a report forecasting technological trends and social implications in the U.S. 55 years ago, and concluded that

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prediction of social implications of technologies is the most difficult aspect of a new technology to foresee, and the attempts to predict them should be minimized. We should keep this lesson in mind, and should not be too optimistic about the possibility of prediction. Our intention is to effectively sense the existing or emerging problems in the society that are perceived only by few expert stakeholders, although some of the problem perceptions might be based on their own prediction about the future.

It should be mentioned that the word "nanotechnologies" is a collective term and has varied meanings depending on the context. For this reason, some people may be of the opinion that we should have specified the target technologies before beginning the assessment. However, setting the target of assessment itself is an important value judgment and should not be done arbitrarily. Therefore, in this paper we apply the problem structuring method to nanotechnologies as a whole on a trial basis. By doing so, we can obtain information on which nanotechnologies should be assessed in greater depth.

The structure of this paper is as follows. In Section 2, we overview previous studies on the ELSI of nanotechnologies, and identify those areas that have not yet been addressed. In Section 3, we propose the procedure of our own problem structuring method. In Section 4, we refer to our case study method. Then, in Section 5, we apply the problem structuring method to nanotechnologies in Japan's context. Sections 6 and 7 are devoted to discussions and the conclusion, respectively.

2. Overview of earlier studies

In this chapter, we first review earlier studies on the societal implications of nanotechnologies. Then, we point out some areas for further research.

It seems that literature on the societal implications of nanotechnologies can be classified into four groups. The literature in the first group, group (1), aims at grasping the whole picture of societal implications (e.g., [1,2,38,47]).

The literatures in the second group, group (2), deal with a particular topic on the societal implications. The topics include (2a) economic implications (e.g., [3]); (2b) implications for developing countries [4,5]; (2c) military applications (e.g., [6,39]); (2d) human enhancement (e.g., [7]); (2e) medical applications (e.g., [52]); and (2e) ethical implications (e.g., [8–11,40,48]).

Literature in the third group, group (3), argues over policies or social systems that should or might be changed according to the development of nanotechnologies. The systems include (3a) the law system (e.g., [12,13]); (3b) intellectual property rights (e.g., [14–16]); and (3c) education system (e.g., [17,18]), among other aspects. Roming Jr. et al. [51] intend to provide policy makers and strategists with observations so that they can avoid societal risks.

Literature in the fourth group, group (4), deals with industrial aspects of emerging technologies including nanotechnologies. For example, Wonglimpiyarat [42] recommends policy implications to encourage national innovativeness and effective commercialization. Hung et al. [43] investigates the ways policy makers can shape the development of emerging technologies like nanotechnologies into new industries. Bhat [44] proposes a framework for understanding industrial innovation of new technologies, and deals with nanotechnology as a case.

Other than the literature classified into the above three groups, some additional literatures exist. They aim at investigating lay people's perceptions and media coverage (e.g., [19–22,41,49,53]), proposing frameworks for the study of nanotechnologies' societal implications (e.g., [23,24]), introducing the results of technology assessments (or part of these results) of nanotechnologies (e.g., [25]), arguing the extent to which nanotechnologies will evolve (e.g., [26–28]), and so on.

Among the major four groups, literature in group (1) only classify potential societal problems induced by nanotechnologies, and explain each topic (e.g., "environment", "health", "privacy"), thus, they do not contain information that serves as a basis for formulating policies in actual contexts. On the contrary, the literatures in groups (2) and (3) attempt to review each topic in further depth, so they have more concrete information. However, they tend not to position each topic in the whole picture and consider the interrelations between the topics.

Although earlier studies tend to lack either concreteness or comprehensiveness, there is an important exception. Renn and Roco [29] list 25 deficits in the risk governance systems of nanotechnologies. However, they still lack concreteness in the sense that they do not take into account the actual context of each country. In addition, they do not clarify possible stakeholders or the difference of perceptions among them. It seems necessary to clarify potential problems taking into account both the context of each country and perceptions of relevant stakeholders in the context.

On the basis of the review of earlier studies stated above, we lay emphasis on the following two principles. (1) We define problems and search possible issues to be addressed in Japan's context based on surveys of relevant stakeholders' perceptions of the current situation. (2) We do not restrict our focus to a particular topic; rather, we attempt to grasp the whole picture.

In order to fulfill these two conditions, we adopt the so-called "problem structuring method." In the following chapter, we introduce this method and show the results of applying it to stakeholders relevant to nanotechnologies in Japan.

3. Introduction to problem structuring methods

When assessing the societal implications of emerging technologies (e.g., nanotechnologies), it is important to provide an appropriate answer to the question "What are the problems?" in the initial phase of technology assessment. In other words, we need to *formulate problems* appropriately. Therefore, in this chapter, we apply a problem structuring method. We introduce the concept of "problem structuring" in this section.

Fairly often in public policy processes, the same fact is interpreted differently among stakeholders. This causes a difference in opinions regarding "what problems should be solved." It is here that problem structuring plays an important role. Problem structuring is a continuously recurring phase of policy inquiry in which analysts search among competing problem formulations of