Societal introduction of nanotechnology

Where natural and social sciences meet

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Conclusions

Nanotechnology possesses many characteristics that may be a focus of societal controversies. Unless the controversies surrounding nanotechnology are carefully managed, they can have negative impacts on the introduction of the technology into society. More specifically, if nanotechnology is allowed to develop in isolation, controversies are likely to occur.

Two complementary approaches to manage societal response are identified. Interaction between natural and social sciences helps to develop nanotechnology applications that are societally desirable. Social sciences research in technology acceptance supports the introduction of such applications. These approaches need to be acted upon as soon as possible to ensure relevant outcomes are available at the moment they are required.

Some research activity is currently occurring in the field of nanotechnology acceptance. However, high quality research specifically focused on nanotechnology acceptance is scarce. Thus research into societal acceptance of nanotechnology and its applications is urgently needed.

Such research should focus on the following:
1. A robust theoretical framework which allows the determinants of societal acceptance of nanotechnology and its applications to be assessed. Such a framework needs to be validated by application of high quality empirical research.
2. Collaboration between natural and social sciences that follows best practice standards. Critical success factors are funding of collaboration initiatives and mutual appreciation for both the natural and social sciences, including the fundamental difference between the two. Interdisciplinary sciences such as Risk Analysis are particularly suited to facilitate natural science - social science collaboration.
3. Learning from previous technology introductions (e.g. biotechnology) by conducting systematic literature reviews.

Background

Nanotechnology is an emerging technology that is expected to make a considerable impact on society in the near future. Public attitudes towards nanotechnology are as yet uncrystallised, but this may change as products become available and societal debate increases. The introductions of many new technologies have been repeatedly accompanied by negative societal reactions. This stresses the need for understanding the determinants of societal response to nanotechnology, especially in the early stages of technology development.

Careful management of the development and societal introduction of nanotechnology requires:
- A robust way of reviewing and classifying lessons learned from the introduction of previous technologies.
- Identification of relevant societal research, and gaps in knowledge.
- Alignment of nanotechnology development with societal needs through interaction between the natural sciences and the social sciences.
- A framework to identify societal needs at different stages of technology development and implementation.

To address these requirements, this report reviews:

- The social science approaches that have been used to understand the level of societal acceptance of emerging technologies, and existing gaps in this knowledge relevant to nanotechnology and society.
- Reports on collaboration between the natural sciences and social sciences to identify best practices and pitfalls for such collaboration.
- The current state of research on societal acceptance of nanotechnology and its determinants.
- Nanotechnology management and stakeholder dialogue strategies for the development and application of nanotechnology.

In addition, the report aims to be a showcase for a systematic literature review following best practice.

Results

The dominant social sciences approaches to understanding societal acceptance of technology fall into one of two broad categories:

- Models based on the rational actor assumption, largely developed in the information technology domain. Determinants of technology acceptance that do not align with the rational actor assumption (e.g. risk perception and affect, or emotional responses) are insufficiently incorporated into the models and are thus not addressed. The most frequently used model is the Technology Acceptance Model (TAM).
- An *ad hoc* use of a broad range of psychological factors (e.g. risk perception, trust, affect).

The issue is that there is no robust theoretical framework that includes all relevant determinants of acceptance.

There is increasing collaboration between the natural and social sciences, but the field is scattered over many areas of theoretical development and application. A review of published collaborations indicates that:

- Acceptance of fundamental differences between the approaches adopted within the natural and social science is an essential precondition of successful collaborations, including:
  - Mutual respect with regard to domain and methods is required.
  - Differences in disciplinary "jargon" must be overcome in order to facilitate communication between researchers from different disciplines.
  - A reductionist approach does not suffice for societal processes.
- Interdisciplinary science can thrive in particular domains, such as risk analysis of new technologies.
- Interdisciplinary research teams can be temporary project based teams, permanent institute teams, or teams of truly interdisciplinary scientists.

Research into societal acceptance of nanotechnology has only just begun. Summarising:

- Thorough investigation of public perceptions of nanotechnology, based on a solid theoretical and empirical basis, is scarce.
- Existing nanotechnology acceptance programs tend to be policy-directed and aim at staging the societal debate, diffusing knowledge and instilling a level of ethical awareness within the natural sciences.

Systematic literature reviews in the social sciences are possible and provide a rigorous overview of the current literature. Review methods need to be extended to allow for meaningful inclusion of all relevant research results. The synthesis of qualitative and quantitative results requires the development of new techniques.

In conclusion, it is important to start:

- Research on a robust theoretical framework for the societal acceptance of nanotechnology.
- Natural science - social science collaboration for the development of nanotechnology applications.
- Systematic learning from previous technology introductions.