Foresight study on the introduction of new technologies: the case of nanotechnology

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Introduction

• New technologies are an important driver of international economic & industrial competitiveness

• There is considerable economic & political pressure to ensure that novel technologies deliver innovations in line with societal priorities and requirements

• New technologies challenge decision-making practices associated with traditional risk and benefit assessment approaches

• A need exists to identify and implement approaches suitable for effective governance of emerging technological innovations
Aims & objectives

To identify the drivers of effective policy in the area of the strategic development of novel technologies, which would contribute to:

1. strengthening the link between technical expressions of risk resulting from health & environmental assessments;
2. identifying methodologies & institutional practices which can facilitate assessment of both the risks and benefits of an event or activity as an input to decision-making associated with technological innovation processes;
3. developing improved risk-benefit metrics to make decision-making explicit, rather than implicit as is the case at present;
4. developing methods to ensure that input from all stakeholders is formally taken into account in the development, governance and commercialisation of emerging technologies.
Work programme

WP1
- Task 1.1 (IOM) Preparation of a Detailed Project Plan
- Task 1.2 (MATTER) Establishment of Advisory Board and Stakeholder Group

WP2
- Task 2.1 (IOM) Mapping of Current Knowledge on Governance
- Task 2.2 (IOM) Development of Governance Landscape
- Task 2.3 (IOM) Initial Mapping of Key Drivers of Effective Policy

WP3
- Task 3.1 (MATTER) Development of Foresight Scenarios
- Task 3.2 (MATTER) Stakeholder Consultation to Test the Governance Landscape in the Foresight Scenarios

WP4
- Task 4.1 (IOM) Preparation of Final Project Report & Recommendations
- Task 4.2 (IOM) Preparation of Publication Manuscript & Conference Presentation
The governance landscape
Nanotechnology and the governance landscape

1. Purpose of Nano Governance
   - Generate Trust & Confidence
   - Ensure Safety & Sustainability
   - Balancing Benefits & Risks
   - Anticipate & Realise Future Developments
   - Responsible Development
   - Innovation versus Risk Governance

2. Challenges of Nano Governance
   - Pace of Development
   - Governance-Development Lag
   - Diversity of Materials & Applications
   - Knowledge Uncertainties
   - E&H concerns
   - Ethical, legal & social issues
   - Adequacy of Existing Procedures
   - Harmonisation
   - Awareness & Perception
   - Knowledge Transfer

3. Existing Nano Governance Approaches
   - Governance Frameworks
   - Risk Management Frameworks/Systems
   - Codes of Conduct
   - Reporting Schemes
   - Standardisation Activity
   - Stakeholder initiatives
   - Government Action Plans & Strategic Initiatives
   - Projects & Dialogue initiatives
### Key Attributes of Existing NanoGovernance Approaches

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Framework 1</th>
<th>Framework 2</th>
<th>Framework 3</th>
<th>Framework 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of best available knowledge &amp; technology</td>
<td>Green</td>
<td>Red</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Foresight</td>
<td>Red</td>
<td>Green</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Flexibility &amp; versatility</td>
<td>Green</td>
<td>Red</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Sufficient means/detail for implementation</td>
<td>Green</td>
<td>Green</td>
<td>Red</td>
<td>Green</td>
</tr>
<tr>
<td>Engagement of stakeholders along the value chain</td>
<td>Red</td>
<td>Red</td>
<td>Green</td>
<td>Red</td>
</tr>
<tr>
<td>Means to establish legitimacy of nanotechnology</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
</tbody>
</table>

- **Red**: Not available or insufficient evidence.
- **Green**: Available evidence.

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**Note:** The table above represents the assessment of key attributes across different governance frameworks. The use of color indicates the level of evidence available for each attribute, with red indicating insufficient or no evidence and green indicating available evidence. This assessment is crucial for understanding the strengths and weaknesses of existing governance approaches in nanotechnology.

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**Reference:**
- Use of best available knowledge and technology:
- Foresight:
- Flexibility and versatility:
- Sufficient means/detail for implementation:
- Engagement of stakeholders along the value chain:
- Means to establish legitimacy of nanotechnology:
Critical uncertainties

i. The style of governance
   • **Mandatory, formal, reactive, closed.** The process of making laws, regulation and decisions is formal and narrow, characterised by a clear focus on codified and statutory requirements that prescribe action in response to challenge.
   • **Managed, anticipatory, open.** Characterised by regulations and decisions that seek to identify, as far as reasonably practicable, risks and opportunities that may emerge and involves broad stakeholder involvement and participation in the making of laws.

ii. The scope of governance
   • **Fragmented, nano-specific regulation.** The focus is on nanotechnologies by virtue of risks and benefits purported to arise from particular size-related properties and from a fragmentation across countries or sectors.
   • **Harmonised, generic regulation.** There is no specific focus on ‘nano’ sized-related risks and benefits; these are integrated within generic laws or sector-based regimes.

iii. Perception of public perception
   • **Erroneous perception.** Public attitudes are perceived erroneously as not accepting of nanotechnologies in products.
   • **Accurate perception.** Public attitudes are perceived correctly as accepting of nanotechnologies in products.
The foresight scenarios

• **Scenario A: ‘Nano-phobia phobia’**
  • Mandatory, formal, reactive and closed governance;
  • Fragmented, nano-specific regulation;
  • The public is erroneously perceived as not accepting nanotechnologies in products.

• **Scenario C: ‘Size still matters’**
  • Managed, anticipatory and open governance;
  • Fragmented, nano-specific regulation;
  • The public is erroneously perceived as not accepting nanotechnologies in products.

• **Scenario F: ‘Nano for growth’**
  • Mandatory, formal, reactive and closed governance;
  • Harmonised, generic regulation;
  • The public is accurately perceived as accepting of nanotechnologies.

• **Scenario H: ‘Open Channels’**
  • Managed, anticipatory and open governance;
  • Harmonised, generic regulation;
  • The public is accurately perceived as accepting of nanotechnologies.
Relative performance of each governance element

<table>
<thead>
<tr>
<th>Key element of the governance landscape</th>
<th>Nano-foresight scenario</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nano-Phobia Phobia</td>
<td>Size Still Matters</td>
</tr>
<tr>
<td>Social &amp; Ethical Assessment, Technology Assessment &amp; Value-Sensitive Design</td>
<td>Positive (weakly)</td>
<td>Positive (weakly)</td>
</tr>
<tr>
<td>Health, Safety &amp; Environmental Risk Assessment</td>
<td>Neutral</td>
<td>Positive (moderately)</td>
</tr>
<tr>
<td>Adoption of Standards</td>
<td>Positive (strongly)</td>
<td>Positive (moderately)</td>
</tr>
<tr>
<td>Commitment to Codes of Practice</td>
<td>Negative (strongly)</td>
<td>Neutral</td>
</tr>
</tbody>
</table>
SWOT analysis

• Aimed to identify:
  • Current strengths of the nano governance landscape
  • Current weaknesses of the nano governance landscape
  • Future opportunities for the nano governance landscape (over the next 20 years)
  • Future threats facing the nano governance landscape (over the next 20 years)

• Key SWOTs analysed in a matrix to explore how:
  • Strengths of the current nano governance landscape might be exploited to:
    • capitalise on future opportunities;
    • counter future threats;
  • Weaknesses of the current nano governance landscape might be tackled to:
    • capitalise on future opportunities;
    • enable future threats to be countered.
## SWOT analysis matrix

<table>
<thead>
<tr>
<th>INTERNAL (current)</th>
<th>EXTERNAL (future)</th>
<th>OPPORTUNITIES</th>
<th>THREATS</th>
</tr>
</thead>
</table>
| Strengths         |                   | - Broader participation, more inclusive fora for debate & deliberation  
|                   |                   | - Existing frameworks & momentum towards governance  
|                   |                   | - Greater focus on governance itself and/or nanotechnology  
|                   |                   | - High profile negative event  | - Broader participation/inclusiveness  
|                   |                   | - Focused, managed, streamlined participation;  
|                   |                   | - Collaborative research/evidence gathering;  
|                   |                   | - Evolve existing frameworks openly, inclusively and visibly reflecting broader sustainability agenda, including anticipation;  
|                   |                   | - Preparedness for the negative event (don’t only be reactive) | - Evaporation of interest in governance and/or nano  
|                   |                   | - International-level consensus with coordination/championing |
| Weaknesses        |                   | - Convert existing frameworks into operational tools (including anticipation, VSD, TA, socio-economic assessment & risk assessment);  
|                   |                   | - Build adaptive capability into existing frameworks (including anticipation);  
|                   |                   | - Promotion/awareness raising of governance itself (what it means, what it includes, what it can achieve, what benefits it can bring);  
|                   |                   | - Research into effectiveness (multi-stakeholder evaluation of current frameworks through research collaboration with a specific focus on what works and doesn’t work at an operational level. Evaluation must cover the broad-scale sustainability agenda;  
|                   |                   | - Preparedness for the negative event;  
|                   |                   | - Assured bonds/shared liability | - Develop process; operational guidance/tools;  
|                   |                   | - Formalise adaptive approach & build capability;  
|                   |                   | - Evidence gathering on effectiveness of governance (including dissemination/knowledge exchange and brokering) & practical operational application;  
|                   |                   | - Mandate (threat of) participation in governance;  
|                   |                   | - Incentivise participation in governance (through e.g. threat of mandatory governance, financial incentive, reputation incentive, supply chain pressure, value chain pressure etc.);  
|                   |                   | - Research into new hazard and risk pathways (academic & applied) and dissemination/knowledge exchange and brokering;  
|                   |                   | - Funding stream for developing operationally-focussed tools (not academic) |
Using strategic foresight to navigate the future governance landscape
Recommendations & research needs

- The interaction of stakeholders, including the general public, NGOs and civil society groups as well as policy makers, academia and business is likely to be an important component of the delivery of optimal governance.

- Actions to strengthen voluntary initiatives in the governance landscape for nanotechnologies might comprise:
  - encouraging the adoption of standards,
  - use of risk assessment,
  - use of social & ethical assessment,
  - an effectiveness review and adoption of codes of conduct.

- An aggregation of the critical outcomes from the SWOT analysis provides recommendations for policy actions (P1-5) and research (R1-3), considering the strengths and weaknesses of the current nanotechnology governance landscape that might be exploited to capitalise on future opportunities and counter future threats.
Recommendations & research needs

• P1. Encouragement, through policy adaptation or development, that due consideration be given to the demonstration of the basic principles of governance, through the use, or consideration, of relevant approaches and tools highlighted in the governance landscape. This may be achieved, for example, through adoption of the recommendations of the British Standards Institution’s code of practice for delivering effective governance of organisations;

• P2. Encouraging an anticipatory and responsive approach in governance;

• P3. Preparedness for a negative event;

• P4. Incentivising participation in governance (e.g. financial incentive, reputation incentive, supply chain pressure, value chain pressure, threat of mandatory governance etc.);

• P5. Mandating demonstration of the adoption of governance approaches.
Recommendations & research needs

• **R1. Evidence gathering on effectiveness and value of governance** (including dissemination/knowledge exchange and brokering) and practical operational application, via a multi-stakeholder evaluation of current frameworks with a specific focus on what works and doesn’t work at an operational level. The evaluation should cover the broad-scale sustainability agenda, and consider the value of existing hazard and risk data (scientific & commercial, academic & applied) as well as emerging evidence;

• **R2. Evolving existing frameworks** openly, inclusively and visibly reflecting broader sustainability agenda, including anticipation;

• **R3. Developing governance processes, operational tools** (including anticipation, VSD, Technology Assessment, socio-economic assessment & risk assessment) and **necessary guidance** for effective implementation;
To implement the aforementioned policy and research recommendations, a series of specific activities through a multi-stakeholder initiative have been identified to **clarify, test and implement a Vision of optimal governance**, considering different governance approaches in the context of overall mandatory and voluntary pathways and understand if and how current initiatives may contribute.
Thank you for your attention