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How are foresight methods selected?

Rafael Popper

Rafael Popper is based at the PREST Manchester Institute of Innovation Research, Manchester Business School, University of Manchester, Manchester, UK.

Abstract

Purpose – *This paper addresses a challenging topic, which in both academic and professional literatures has been widely discussed but mainly from one single angle – that is, how to select foresight methods. From that point of view researchers and consultants promote (even if unintentionally) the use of particular methods. Here the question of selection is raised from a different perspective: how are foresight methods selected?*

Design/methodology/approach – *The guiding ''theory'' is that a better understanding of the fundamental attributes of foresight methods and their linkages to the core phases of a foresight process, together with the identification of possible patterns in the selection of methods, will provide useful insights as to how the selection of methods is carried out.*

Findings – *So far the selection of foresight methods has been dominated by the intuition, insight, impulsiveness and – sometimes – inexperience or irresponsibility of practitioners and organisers. This paper reveals that the selection of foresight methods (even if not always coherent or systematic) is a multi-factor process, and needs to be considered as such.*

Practical implications – *The results can be utilised by lecturers and students to describe and understand better the use of foresight methods, and by organisers of foresight (including practitioners) to better inform decisions during the design of (hopefully) more coherent methodological frameworks.*

Originality/value – *The paper combines practical concepts and frameworks (such as the Foresight Process and the Foresight Diamond) with innovative analyses to represent and visualise better the combination of methods in 886 case studies, for example introducing the Methods Combination Matrix (MCM) to examine the dynamics of a mix of methods.*

Keywords *Research methods, Design, Forward planning, Strategic planning, Creative thinking, Decision making*

Paper type *Research paper*

Introduction, hypotheses, case studies and approach

This paper is based on the various outputs of the EFMN[1] monitoring activities (see Popper *et al.* 2005, 2007a, b; Keenan *et al.*, 2006) and a sister initiative carried out in Spanish by the SELF-RULE network[2]. After four years of systematically researching nearly 2,000 foresight exercises from around the world, these monitoring activities have built up databases[3] of case studies that offer tremendous potential to better understand global foresight practices. This research process, hereinafter referred to as *mapping*, has consisted of four major activities:

1. In the first instance, foresight studies were identified by dedicated network partners, who continuously searched the internet, public reports, etc. In addition, national correspondents were mobilised and invited to suggest studies on an annual basis.
2. The second activity was the actual mapping or data entry, using a set of indicators to capture the different elements of a *foresight process* (e.g. methods, country or world region, territorial scale, time horizon and type of sponsorship, among others). From the

almost 2,000 cases identified, about half have been fully mapped against the majority of indicators.

3. The third activity was the quality control of the data. This task involved sending automated e-mails with a direct link to the database so that national correspondents could update and improve the quality of mapped cases. This approach had mixed results, so that some exercises are much better mapped than others.

4. Finally, the fourth activity involved processing, experimentation and analysis of the data set. These analyses have been used to prepare *annual mapping reports* which have been openly shared with the foresight community and have set the basis for the questions and hypotheses addressed in this article.

To begin with, this paper is based on a sample of 886 foresight studies: 36 cases looking at Europe, Africa or Asia as a whole, thus considered supra-national studies, and 850 cases linked to specific countries and including a mix of sub-national, national and supra-national experiences. But given that much foresight is increasingly embedded (see Salo and Salmenkaita, 2002) in wider research and development (R&D) policies, in this paper the country-related studies are clustered into seven geo-R&D contexts – taking into account the country's geographic location and its gross expenditure on R&D (GERD) as a percentage of GDP (European Commission, 2007)[4]. As a result, the country-related sample includes:

- 313 cases from three high-R&D groups with R&D intensities above 2.4 per cent of GDP – consisting of 174 cases from Europe (Austria, Denmark, Finland, France, Germany, Iceland, Israel, Sweden and Switzerland), 109 cases from North America (Canada and the USA), and 30 cases from Asia (Japan and South Korea).
- 313 cases from two medium-R&D groups with R&D intensities between 1.5 per cent and 2.2 per cent of GDP – consisting of 299 cases from Europe (Belgium, Luxembourg, The Netherlands, Norway and the UK), and 14 cases from Australia.
- 224 cases from two lower-R&D groups with R&D intensities below 1.5 per cent of GDP – consisting of 110 cases from Europe (Bulgaria, Cyprus, Czech Republic, Estonia, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Turkey) and 114 cases from South America (Argentina, Brazil, Chile, Colombia, Peru and Venezuela).

However, the reader should be aware of limitations with the databases. To begin with, the mapping of foresight has to contend with inevitable biases, such as language and the high visibility of national-level activities. These have implications for the mapping data collected, with some types of activities, for example sub-national foresight, under-represented in the database. Moreover, data has been collected by a network of correspondents, which, given that some of the indicators used are open to interpretation, has sometimes resulted in a lack of consistency in mapping. Some of these challenges are difficult to fully resolve, but the data could be much improved if a more targeted monitoring strategy was undertaken to better cover the sub-national level, for example. At the same time, some countries where foresight is also practised have been insufficiently monitored so that their foresight activity is under-represented in our data, for example China, India, Taiwan and Mexico. There are other limitations of the mapping that have motivated the above-mentioned quality control. Some have to do with *problems of inclusion* (where very small visioning or strategic planning studies have been mapped as foresight); others with *problems of exclusion* (where the body of work in a particular sector is underrepresented, such as private sector foresight, work on skills, jobs and occupations, or studies on the military and defence sectors, for example).

Having both these possibilities and limitations in mind, the mapping still offers a unique opportunity to unlock information on a wide range of issues about foresight practices in the world. This information is here used to address a challenging topic, which has been widely discussed in both academic and professional literatures, but mainly from one single angle – that is, how to select foresight methods. From that perspective researchers and consultants promote (even if unintentionally) the use of particular methods. Instead, in this paper, the question of selection is raised from a different viewpoint: how are foresight methods selected? The guiding ''theory'' is that a better understanding of the fundamental *attributes* of foresight methods and their linkages to the core phases of a *foresight process*, together with the identification of possible patterns and relationships, will provide useful insights as to how the selection of methods is carried out.

Two interconnected hypotheses are tested in this article:

- The first hypothesis is that *methods are chosen based on their ''intrinsic attributes''*, such as their *nature* (i.e. qualitative, quantitative or semi-quantitative) and their *capabilities* (i.e. the ability to gather or process information based on evidence, expertise, interaction or creativity), for example.
- The second hypothesis is that *methods are chosen based on fundamental elements and conditions influencing the foresight process*; in other words, *foresight process needs* matter. This idea is not radically new, but has remained no more than a reasonable conjecture up until now, mainly ''validated'' through practice or tacit knowledge and yet to be proven.

Of course, in both futures and foresight literatures there have been plenty of discussions about processes, generations, challenges, classifications and various ''styles'' of forward-looking practices and methods (De Jouvenel, 1967; Boucher, 1977; Coates, 1985; Jungk and Müllert, 1987; Cameron *et al.*, 1996; Bell, 1997; Glenn and Gordon, 1999; Godet, 2000, 2001; Georghiou, 2001; Masini, 2001; Miles, 2002, 2008; Cuhls, 2003; Voros, 2003, 2005; Kaivo-oja *et al.*, 2004; Bishop *et al.*, 2007; Barré, 2008; Popper, 2008; Popper and Medina, 2008; Johnston and Sripaipan, 2008; Keenan and Miles, 2008; Keenan and Popper, 2008). Even though these and many other contributions provide a huge ''knowledge base'' of definitions, frameworks and experiences using a wide range of real – and occasionally hypothetical – examples, up until now there has not been a systematic and organised effort to explain ''how foresight methods are selected'' using such a large number of case studies.

With this in mind, a deductive approach will be taken to analyse the mapping data and to present it in various ways so that the hypotheses above are confirmed or rejected. The paper is structured around four sections. After this introduction, there is a section describing the above-mentioned *attributes* of foresight methods and their expected contribution to the five core phases of a *foresight process* (pre-foresight, recruitment, generation, action and renewal). Here is where the 11 elements considered and analysed throughout the paper will be introduced (section 2). This is followed by a section on key findings, which uses a sample of 886 case studies to show how the previously described elements influence the selection of foresight methods (section 3). Finally, section 4 concludes with a snapshot summary of major findings.

2. Definitions and frameworks

This section provides definitions and frameworks related to the hypotheses tested in this article. It basically sets the context for the various assumptions made in the paper by describing and exploring the various influencing factors on the selection of foresight methods.

2.1 Fundamental attributes of foresight methods

Let us begin by describing two fundamental ''attributes'' of foresight methods (see the Appendix):

1. *nature*; and
2. *capabilities*.

With regards to their *nature*, methods can be characterised as qualitative, quantitative or semi-quantitative:

- *Qualitative methods* generally provide meaning to events and perceptions. Such interpretations tend to be based on subjectivity or creativity that is often difficult to corroborate, for example opinions, judgements, beliefs, attitudes, etc. In the mapping, 15 qualitative methods have been included: backcasting, brainstorming, citizens' panels, environmental scanning, essays, expert panels, futures workshops, gaming, interviews, literature review (LR), morphological analysis, questionnaires/surveys, relevance trees, scenarios, and SWOT analysis.

- *Quantitative methods* generally measure variables and apply statistical analyses, using or generating – at least in theory – reliable and valid data, such as socio-economic indicators. The mapping considered three quantitative methods: bibliometrics, modelling/simulation, and trend extrapolation/megatrends (or simply extrapolation).
- *Semi-quantitative methods* are basically those that apply mathematical principles to quantify subjectivity, rational judgements and viewpoints of experts and commentators, i.e. weighting opinions and probabilities. The mapping included six methods from this category: cross-impact/structural analysis, Delphi, key technologies, multi-criteria analysis, stakeholder mapping and (technology) roadmapping.

A category labelled ''other methods'' was also included in mapping. This was often used to indicate if an exercise applied methods like benchmarking and patent analysis, among others.

The second attribute refers to the *capabilities* of methods – in other words, the ability to gather or process information based on evidence, expertise, interaction or creativity. These attributes are not exclusive or restrictive; in fact, they could be better understood if presented as ''genetic'' components of a method. Using the same analogy, the ''genetic structure'' of an activity carried out using *expert panels* could be estimated as consisting of:

$$70 \text{ per cent expertise} + 10 \text{ per cent evidence} + 10 \text{ per cent creativity} + 10 \text{ per cent interaction},$$

while the same activity carried out using citizens' panels could consist of:

$$10 \text{ per cent expertise} + 10 \text{ per cent evidence} + 10 \text{ per cent creativity} + 70 \text{ per cent interaction}.$$

So, let us briefly describe each of these attributes[5].

- *Creativity* refers to the mixture of original and imaginative thinking and is often provided by artists or technology ''gurus'', for example. These methods rely heavily on the inventiveness and ingenuity of very skilled individuals, such as science fiction writers or the inspiration that emerges from groups of people involved in *brainstorming* sessions (see also Ansoff, 1975; Cassingena Harper and Pace, 2004).
- *Expertise* refers to the skills and knowledge of individuals in a particular area or subject and is frequently used to support top-down decisions, provide advice and make recommendations. These methods rely on the tacit knowledge of people with privileged access to relevant information or with accumulated knowledge from several years of working experience on a particular domain area. Expertise often allows for a more holistic and comprehensive understanding of the theories, hypotheses and observations of a study (see also Kuusi, 1999; Scapolo and Miles, 2006).
- *Interaction* recognises that expertise often gains considerably from being brought together and challenged to articulate with other expertise (and indeed with the views of non-expert stakeholders). So, given that foresight studies often take place in societies where democratic ideals are widespread, and legitimacy is normally gained through ''bottom-up'' and participatory processes, it is important that they are not just reliant on evidence and expertise (see also Andersen and Jæger, 1999; Cuhls, 2003; Brummer *et al.*, 2007).
- *Evidence* recognises that it is important to attempt to explain and/or forecast a particular phenomenon with the support of reliable documentation and means of analysis of, for example, statistics and various types of measurement indicators. These activities are

particularly helpful for understanding the actual state of development of the research issue (see also Porter *et al.*, 1980; Armstrong, 2006).

The above attributes are the building blocks of the *Foresight Diamond* (see Figure 1), which, in this paper, has been adapted to highlight the 25 methods considered in the mapping[6].

2.2 Fundamental elements of foresight processes

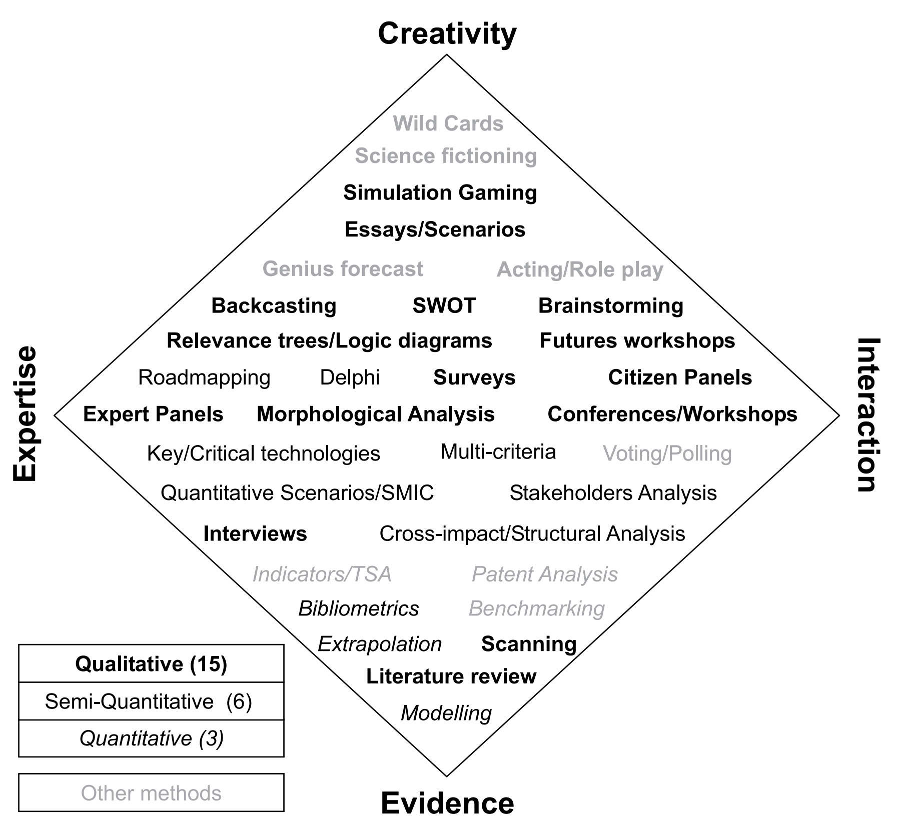
Foresight has been increasingly understood as a systematic process with five interconnected and complementary phases:

1. pre-foresight;
2. recruitment;
3. generation;
4. action; and
5. renewal (see Miles, 2002; Popper, 2008).

And given that the second hypothesis of this paper relates the selection of methods to the elements and conditions influencing the foresight process, in this section, nine fundamental elements (used in the mapping) will be shortly described and presented within the foresight process context (see Figure 2):

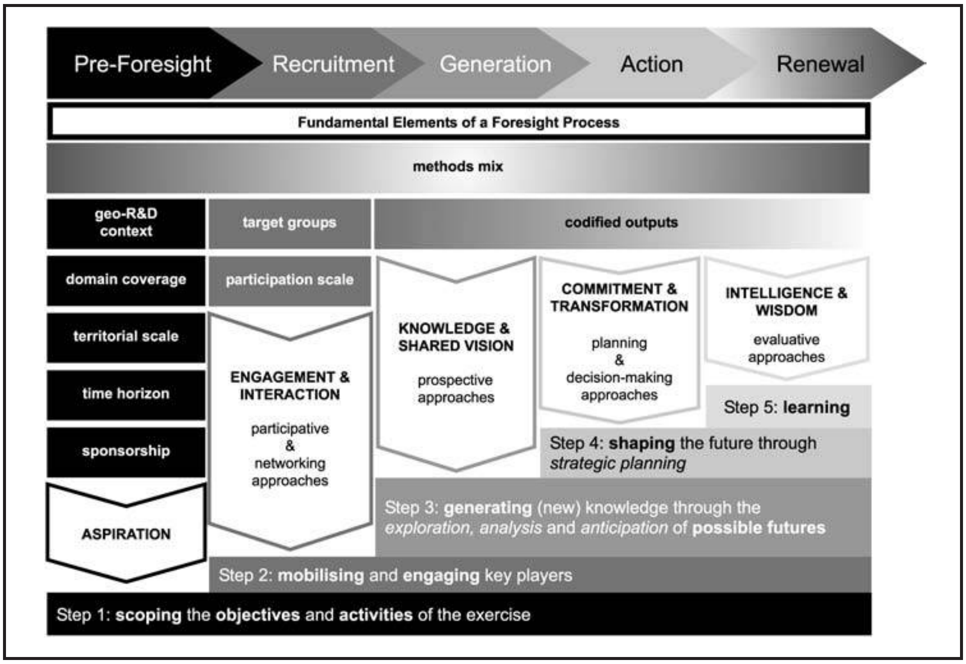
- five pre-foresight elements (i.e. the geo-R&D context, domain coverage, territorial scale, time horizon, and sponsorship);

Figure 1 The Foresight Diamond



Source: Adapted from Popper (2008)

Figure 2 The foresight process



- two recruitment elements (target groups and participation scale);
- one cross-cutting element which relates to all phases of the process but is commonly assigned to the generation phase (i.e. methods mix); and
- one element which results from the generation phase but influences both *action* and *renewal* phases (i.e. codified outputs).

The *pre-foresight* or *scoping* phase is where strategic and early process decisions are made. The strategic decisions have to do with elements related to the overall *aspirations* of an exercise (rationales, general and specific objectives, workplan, expected outcomes, etc.), while the early process decisions relate to six of the ten elements used in this paper as potential factors influencing the selection of methods. These are:

1. *Geo-R&D context* – A factor used to cluster countries into world regions taking into account the gross expenditure on research and development (GERD) as percentage of GDP. As mentioned in the introduction, seven geo-R&D contexts will be considered.
2. *Domain coverage* – Refers to the sector, industry or research area covered by the study. This paper uses the NACE classification of industries/sectors to analyse how foresight methods have been used in the eight most commonly studied domains.
3. *Territorial scale* – Refers to the geographical scope of a study, which can be sub-national (regional), national and supra-national (international).
4. *Time horizon* – Refers to the selected time scale of a study. Five ranges are used in this paper: until 2010, 2011-2020, 2021-2030, 2031-2050 and 2051-2100.
5. *Sponsorship* – Refers to the type of actor(s) funding and supporting a study. Common sponsors of foresight include the government, non-state actors (including IGOs and NGOs), research actors (particularly research funding agencies) and the business sector.

The *recruitment* phase is about enrolling key individuals and stakeholders who can contribute with their knowledge and expertise on particular issues and promote the research process within their own networks. For practical reasons it is presented as the second phase of the process but the engagement of and interaction between stakeholders is needed through the life of a study. Two fundamental elements of this phase are analysed in this paper:

1. *Target groups* – Refer to the type of stakeholders (users/audiences/contributors) that have been involved in the study. Eight categories are considered: government agencies and departments, research community, firms, trade bodies and industrial federations, NGOs, intermediary organisations, trades unions and ''other audiences''.

2. *Participation scale* – Refers to the level of openness of a study, but openness is not necessarily well captured by simply looking at the scale of participation given that its *scope* is more important; however, the latter has not been captured in the mapping.

The *generation* phase is the ''heart'' of a foresight process, given that here is where prospective knowledge and shared visions are generated. It is therefore the phase in which ''codified knowledge'' is fused, analysed and synthesised; ''tacit knowledge'' is gathered and contrasted with codified knowledge; and (hopefully) ''new knowledge'' is generated, such as shared visions and images of the future. This phase involves three interdependent activities:

1. *exploration* – using methods like *LR*, *scanning* or *brainstorming* to identify and understand important issues, trends and drivers;

2. *analysis* – using methods like *expert panels*, *extrapolation* or *SWOT* to understand how the context and main issues, trends and drivers influence one another; and

3. *anticipation* – using methods like *scenarios* or *Delphi* to anticipate possible futures or suggest desirable ones.

Two vital elements of this phase are analysed in the paper:

1. codified outputs; and

2. the ''methods mix''.

The former behaves like a ''transverse wave'' which begins in the *generation* phase and propagates through the *action* and *renewal* phases (see below), and possibly goes on to create a new *pre-foresight* phase. The latter is a cross-cutting element with its ''epicentre'' in the *generation* phase and waves of influence propagating into the other phases, thus shaping the ultimate outcomes of a foresight exercise. The two elements analysed in this paper are:

1. *codified outputs* – refers (in this paper) to the production of policy recommendations, analysis of trends and drivers, scenarios, research and other priorities, lists of key technologies, forecasts and technology roadmaps; and

2. *methods mix* – refers to the combination of foresight methods.

The factor itself is based on a schema introduced to examine the dynamics of methods mix, i.e. the Methods Combination Matrix (MCM). This result is used in the paper to describe the interconnections between foresight methods and to explore whether correlations between methods could explain their selections (see below).

The *action* and *renewal* phases are heavily influenced by the type, quantity, quality, relevance, usability and timely production of codified (and process-related) outputs, among others. *Action* is about reaching commitment from key players who are ready to embark on the ''business of transforming and shaping the future'' through the implementation of the policies and decisions produced in the *generation* phase. At this phase, the foresight process should link with traditional strategic planning processes in order to define realistic medium-to-long-term action plans. This bridge between foresight and planning is sometimes achieved with methods like *roadmapping* and *morphological analysis*, for example. *Renewal* is a mixture of intelligence and wisdom. It is about gaining knowledge and understanding of the opportunities and threats identified in the codified outputs and the process itself. This phase requires the use of evaluative approaches and, in particular, of traditional social research methods like interviews, LR and opinion surveys[7].

3. So, how are foresight methods selected?

Having described the attributes of foresight methods and the elements of a foresight process, it is now time to recall the main question of the paper: how are foresight methods selected? The answer requires tackling 11 equally complex questions, two of which are related to the attributes of methods:

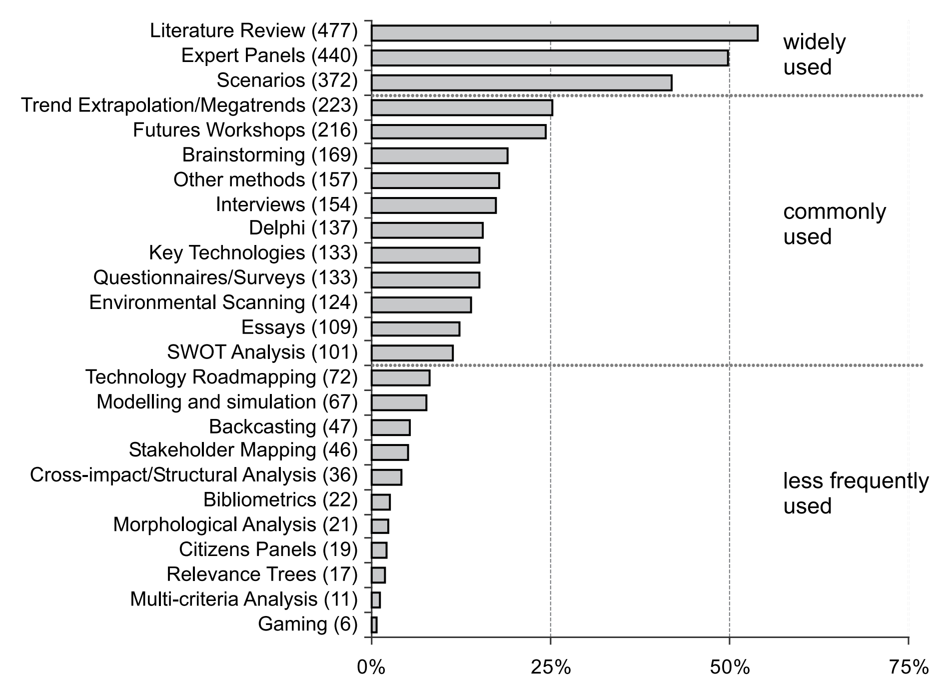
1. How is selection influenced by the *nature of methods*?
2. How is selection influenced by the *capabilities of methods*?

The other nine are more closely related to the *elements* of *foresight processes*:

1. How is selection influenced by the *geo-R&D context*?
2. How is selection influenced by the *domain coverage*?
3. How is selection influenced by the *territorial scale*?
4. How is selection influenced by the *time horizon*?
5. How is selection influenced by the *sponsorship*?
6. How is selection influenced by the *target groups*?
7. How is selection influenced by the *participation scale*?
8. How is selection influenced by the *codified outputs*?
9. How is selection influenced by the *methods mix*?

But before embarking upon this journey, let us first present the results of the basic frequency count data on the extent to which 25 foresight methods are used in 886 cases. In Figure 3, the number of times each method was used is indicated in parentheses next to the method.

Figure 3 Level of use of foresight methods



Note: 886 cases

Sources: EFMN and SELF-RULE (2008)

For example, *expert panels* was applied 440 times. The frequency of use of methods clearly shows three blocks or groups:

1. the *widely used* methods are LR, expert panels and scenarios, all of which are qualitative;
2. the category of *commonly used* methods includes extrapolation/megatrends, futures workshops, brainstorming, other methods, interviews, Delphi, questionnaire/survey, key technologies, scanning, essays and SWOT; and
3. the group of *less frequently used* methods include roadmapping, modelling/simulation, backcasting, stakeholders mapping, structural analysis, bibliometrics, morphological analysis, citizen panels, relevance trees, multi-criteria and gaming.

While the data suggests that this group of methods is rarely used, some of the numbers here are lower than might be anticipated and can probably be assigned to biases arising from the mapping. For example, methods such as structural analysis and relevance trees have been occasionally applied in Spain and France at the sub-national level. But because mapping at this level has been weaker than at the national level, the data does not do justice to the likely higher frequency of their applications.

This information could raise one additional question: how many methods are used in an ''average'' foresight study? Figure 4 shows that on average, five or six methods are used per initiative. However, the variation is high, so it can be concluded that the diversity of methods used is also high. But, these numbers should not be taken for granted. As we have already mentioned, foresight exercises tend to use multiple methods in their methodological designs. There are other factors considered in the remainder of this paper that need to be added to the equation. In any case, knowing the level of use of methods and the ''average'' number of methods used in a project is a very good starting point for the eleven-question journey!

3.1 How is selection influenced by the ''nature of methods''?

Figure 5 shows the nature of commonly and widely used foresight methods. The results reveal that the top three and a total of ten out of 14 methods are qualitative, thus suggesting that qualitative attributes are more ''popular'' or well liked than quantitative and semi-quantitative ones. Such popularity may be due to the fact that the study of the future is inevitably informed by opinions and judgements based on subjective and creative interpretations of the changes (or lack of changes) creating or shaping the future. And these attributes are mostly found in qualitative techniques. Literature review (LR) is a fundamental research method extensively used in every discipline, and therefore it does not surprise that it comes in at the top position. Indeed, despite these relatively high numbers, a foresight practitioner would believe that LR and other generic methods, such as open-ended surveys, are being under-reported in the database. Delphi and key technologies are both used in 15 per cent of studies. They are the only semi-quantitative techniques among the most commonly used methods list. At the same time, extrapolation is the only quantitative method, perhaps because it is a very useful technique to explain how ''lack of changes'' in the

Figure 4 Number of methods used in foresight exercises

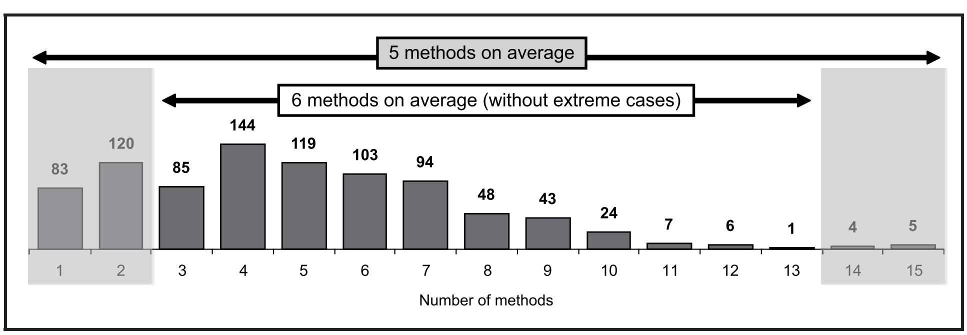
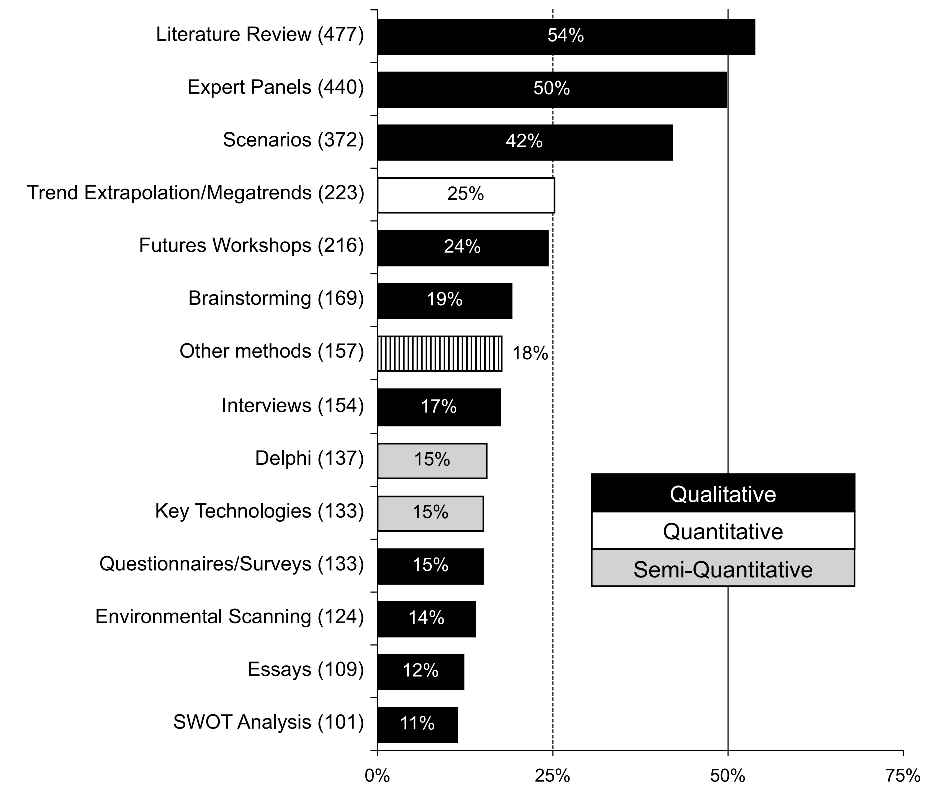


Figure 5 Nature of most commonly used foresight methods



Note: 886 cases

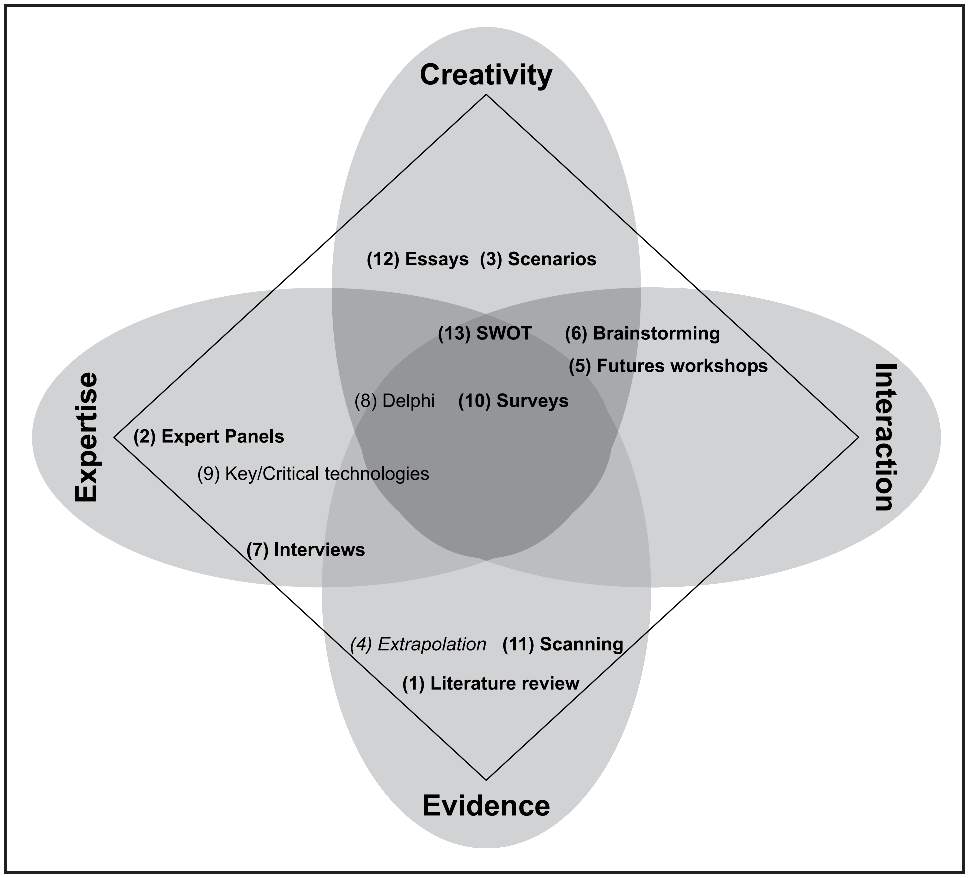
Sources: EFMN and SELF-RULE (2008)

present may be reflected in the future. So, the influence of the nature of methods is very high, and is biased towards qualitative methods.

3.2 How is selection influenced by the ''capabilities of methods''?

Figure 6 shows an impressionistic representation of the most commonly used methods inside the Foresight Diamond framework. The shading reflects the overall ability to gather or process information based on evidence, expertise, interaction or creativity. Here it is worth noting that the interaction dimension is first ''touched'' by methods like futures workshops and brainstorming (although some types of expert panels are designed to promote participation and interaction between groups of stakeholders). Considering that these methods are in fifth and sixth positions in terms of frequency of use, the previous assumption that an ''average'' study may combine five or six methods suggests that – even with the already mentioned problems of inclusion – the mapped foresight work is aligned with concepts accepted by the community of practitioners, where foresight is seen as a way to encourage more structured debate with wider participation leading to the shared understanding of long-term issues (Georghiou *et al.*, 2008). The picture shows that most projects using five or more methods tend to select them – even if by chance – in a way that the four fundamental capabilities of methods are met. The reader should also note that there are no commonly used methods near the top vertex of creativity. This may be a consequence of the lack of guidance on how to apply techniques such as gaming and other creative methods like wild cards or weak signals[8].

Figure 6 Capabilities of most commonly used foresight methods



So, the influence of the capabilities of methods is high, but not balanced. At the same time, however, it would be unrealistic to expect all foresight studies to give an equal weighting to all four vertices of the Foresight Diamond.

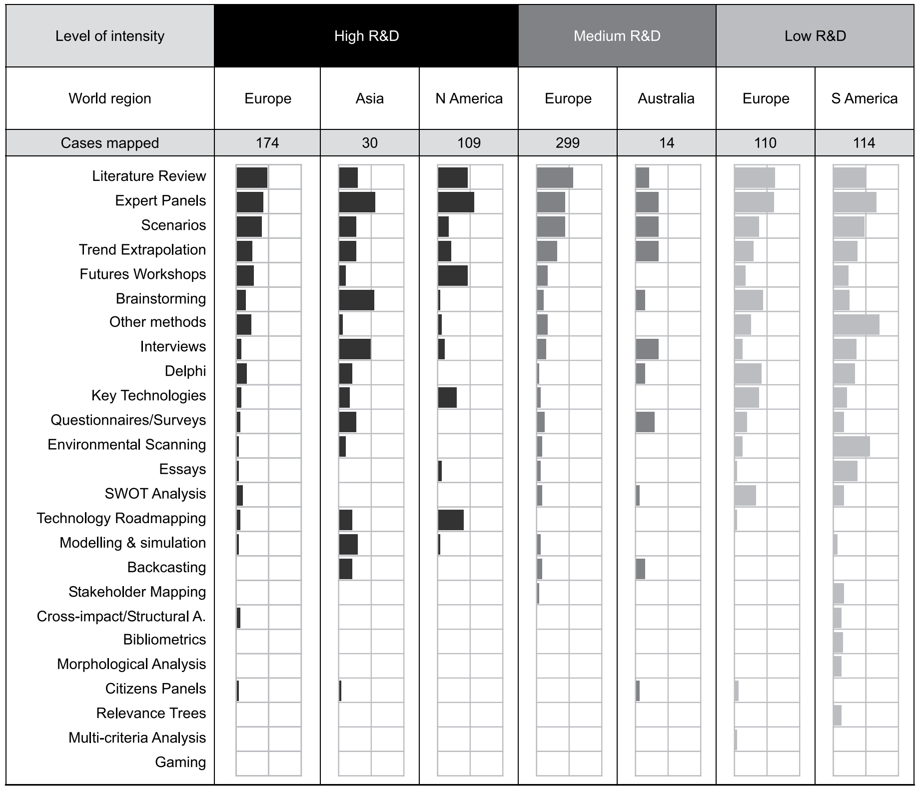
3.3 How is selection influenced by the ''geo-R&D context''?

The consideration of the geo-R&D context (see above) as one of the factors influencing the selection of foresight methods has proven an interesting proposition. While the previous question was about the capabilities of methods, the geo-R&D context could (but not always) reflect the capabilities to use the methods.

For example, Figure 7 shows that methods that rely on the availability of knowledge about emerging/cutting-edge technologies are more often used in high-R&D intensity countries. Such is the case for *roadmapping* (commonly used in North America) and *modelling* (well liked in high-R&D Asia). Here the reader may wonder why Delphi usage does not behave according to the implicit hypothesis. A possible explanation is that nowadays Delphi is much more widely used as a tool to explore how technologies may interact or shape possible application environments in the future (e.g. R&D infrastructures or socio-economic sectors), as opposed to the traditional technological orientation that the method had during the second half of the twentieth century (see Popper and Miles, 2005).

Countries with lower R&D intensities tend to use exploratory and comparative techniques, for example scanning, SWOT, bibliometrics and other methods, such as benchmarking and patent analysis which were included in the South American SELF-RULE mapping instrument[9].

Figure 7 Methods versus geo-R&D context



Note: 850 cases

Sources: EFMN and SELF-RULE (2008)

The results also show that the R&D context has little influence in the selection of the top three methods in Europe, but it does have a stronger influence in further selections. For instance, in lower-R&D Europe, brainstorming, Delphi and key technologies are in much higher positions (fourth, fifth and sixth, respectively).

Other remarkable findings include:

- lower use of LR in high-R&D Asia and Australia;
- lower use of scenarios in North America (but note the higher use of futures workshops);
- rather high use of brainstorming, interviews and modelling in Asia;
- very high use of other methods in South America (evidence of the use of mixed approaches, e.g. productive chains, competitive intelligence, and the tools of *la prospective*, such as MICMAC/MACTOR/SMIC);
- Delphi being used mainly in Asia, low-R&D Europe and South America, and not present in over 100 cases mapped from North America;
- predominantly high use of scanning and essays in South America;
- high use of SWOT in low-R&D Europe;
- backcasting being practised mainly in Asia and Australia; and
- methods like structural analysis, stakeholders mapping and relevance trees more likely to be used in South America – this reflects a latent methodological lock-in caused by early practitioners in the region.

In addition, the size of the bars in Figure 7 show that low R&D intensity countries include more methods in the methods mix.

In summary, the influence of the geo-R&D context would seem to be rather high. However, the reader should be careful in making assumptions or generalisations based on Figure 7, given that, for example, the apparent high use of key technologies in lower-R&D Europe is pretty much a result of applications of the method in one particular country, i.e. Spain.

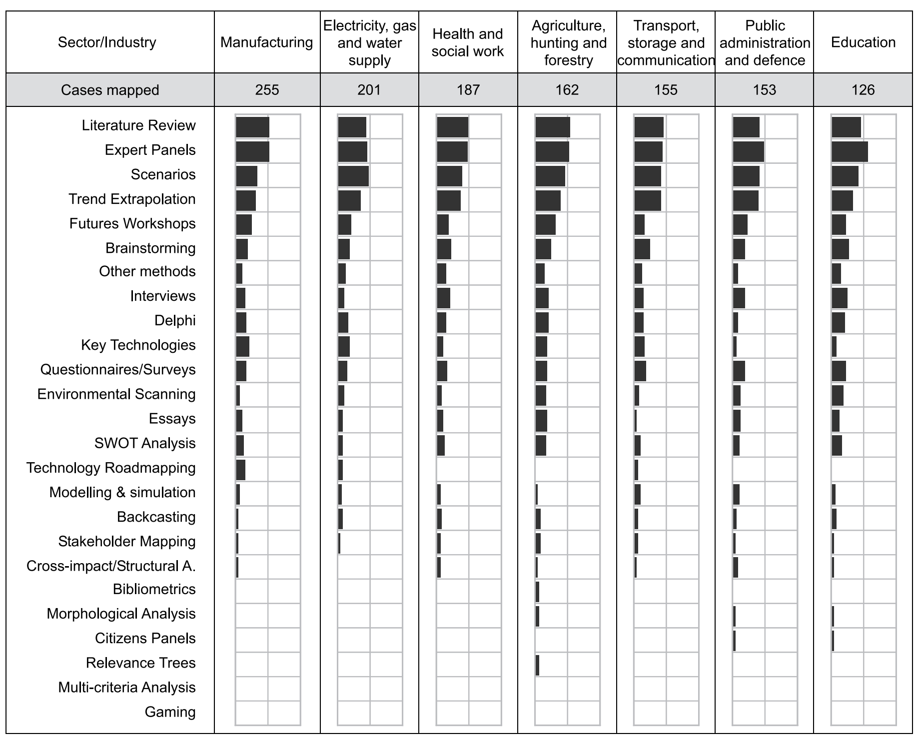
3.4 How is selection influenced by the ''domain coverage''?

Figure 8 shows the use of methods in the seven ''best-mapped'' sectors/industries from a list of 17 categories used in the EC's NACE classification. These are:

1. manufacturing;
2. electricity, gas and water supply;
3. health and social work;
4. agriculture, hunting and forestry;
5. transport, storage and communication;
6. public administration and defence; and
7. education.

The results show an even and fairly proportional use of all methods across the seven domains. The reason for the agriculture bars looking slightly bigger than other sectors' bars has to do with the high number of South American cases in this domain, where more

Figure 8 Methods versus domain coverage



Note: 804 cases. The mapping of domains allows for multiple selections

Sources: EFMN and SELF-RULE (2008)

methods tend to be included in the methods mix. Even so, two comments can be made about the charts: the first is that roadmapping seems to be more commonly used in:

- manufacturing;
- electricity, gas and water supply (and the energy sectors in general); and
- transport, storage and communication.

The second is that less frequently used methods tend to be applied to domains such as agriculture, public administration and education.

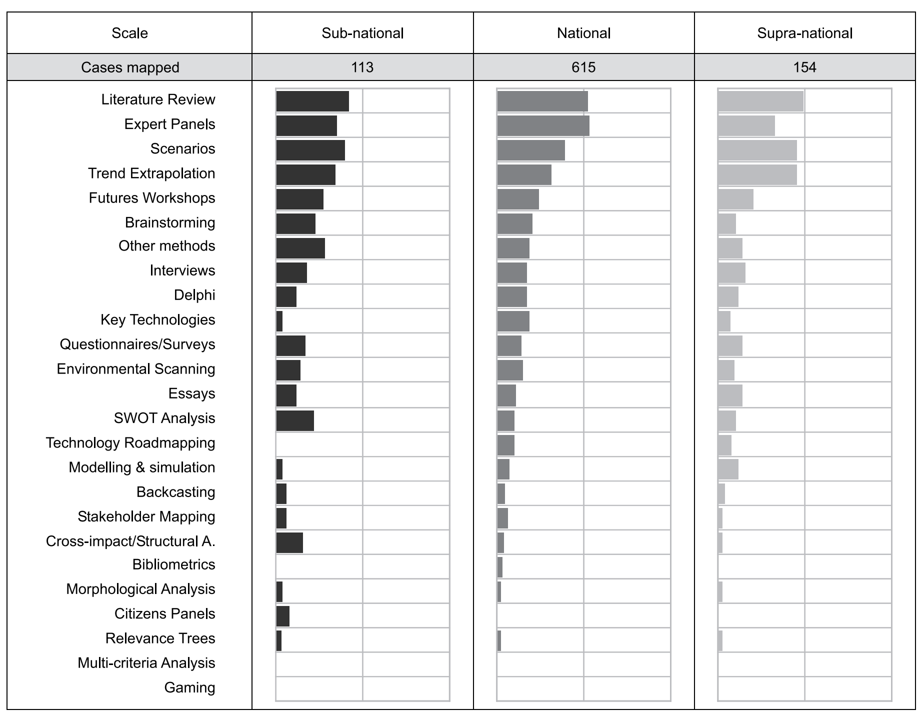
Therefore, the influence of the domain coverage is relatively low.

3.5 How is selection influenced by the ''territorial scale''?

Even among foresight practitioners it has been often believed that methods used in sub-national or regional exercises are different from those applied at the national and supra-national levels. Nonetheless, Figure 9 reveals that such a difference is not very big.

One can argue that there are role-related and technical constraints, which could make the use of a particular method unattractive. For instance, sub-national studies rarely have the power to enact big S&T programmes, which is more of a ''territory'' or role of national governments – and of the European Commission at the European Union level. For this reason, roadmapping, key technologies and modelling are less likely to be carried out at this level. As for the technical limitations, lower figures in the use of brainstorming and SWOT at the supra-national level reflect the current practical difficulties of organising large-scale meetings with experts from different countries, although advancements in ICTs could change this in the future. However, methods like citizen panels, SWOT, and cross-impact are practised more at this level.

Figure 9 Methods versus territorial scale



Note: 882 cases

Sources: EFMN and SELF-RULE (2008)

The above suggests that the influence of the territorial scale on selection is at best moderate.

3.6 How is selection influenced by the ‘‘time horizon’’?

With the exception of expert panels and scenarios, where the use increases as the time horizon gets longer, Figure 10 shows no clear patterns explaining the relationship of methods *vis-à-vis* the time horizon. This may be a consequence of the lack of relevant literature and discussion *fora* on the pros and cons of foresight methods with regards to their effectiveness and capabilities to navigate into near, far or even far-off futures. In fact, the most interesting results, even if poorly represented, emerge from exercises with very large time horizons (2051-2100) where scenarios were always used, and were combined with extrapolation, modelling/simulation, backcasting, brainstorming, roadmapping or gaming. Other findings include:

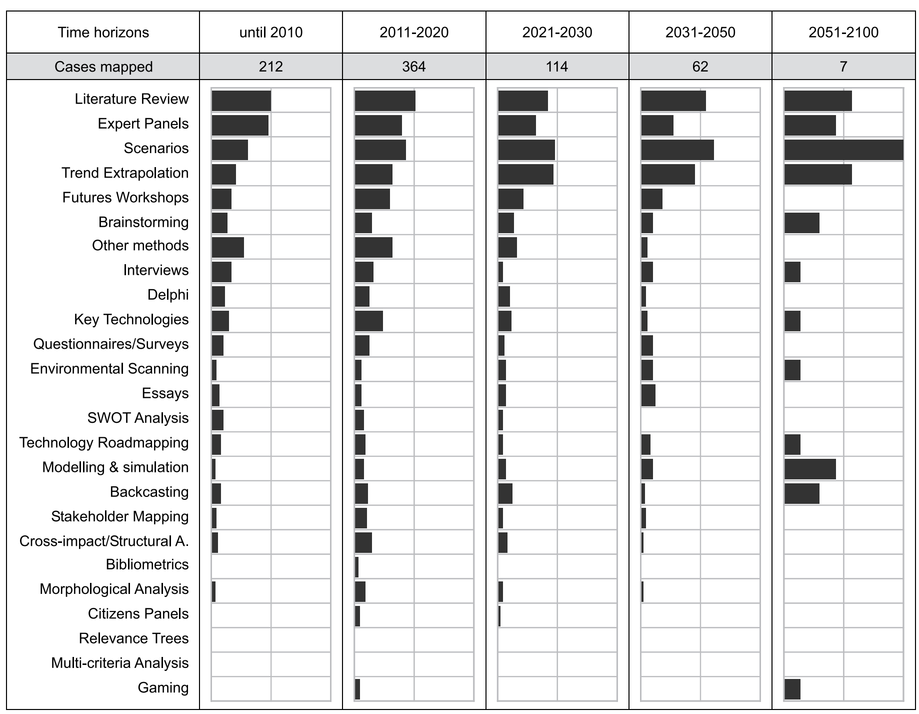
- decreasing use of Delphi as the time horizon gets longer;
- increasing use of scanning as the time horizon gets longer; and
- absence of SWOT and bibliometrics in studies looking into the far future.

But even given the already mentioned information deficit on the challenges that different time horizons pose to a study, the results still show a moderate influence of the chosen time horizon on the selection of methods.

3.7 How is selection influenced by ‘‘sponsorship’’?

Figure 11 presents the use of methods in studies sponsored by the government, non-state actors, research actors and businesses. The main finding here is that studies sponsored by non-state actors (i.e. NGOs as well as IGOs, like the EC and UNIDO) are more demanding in

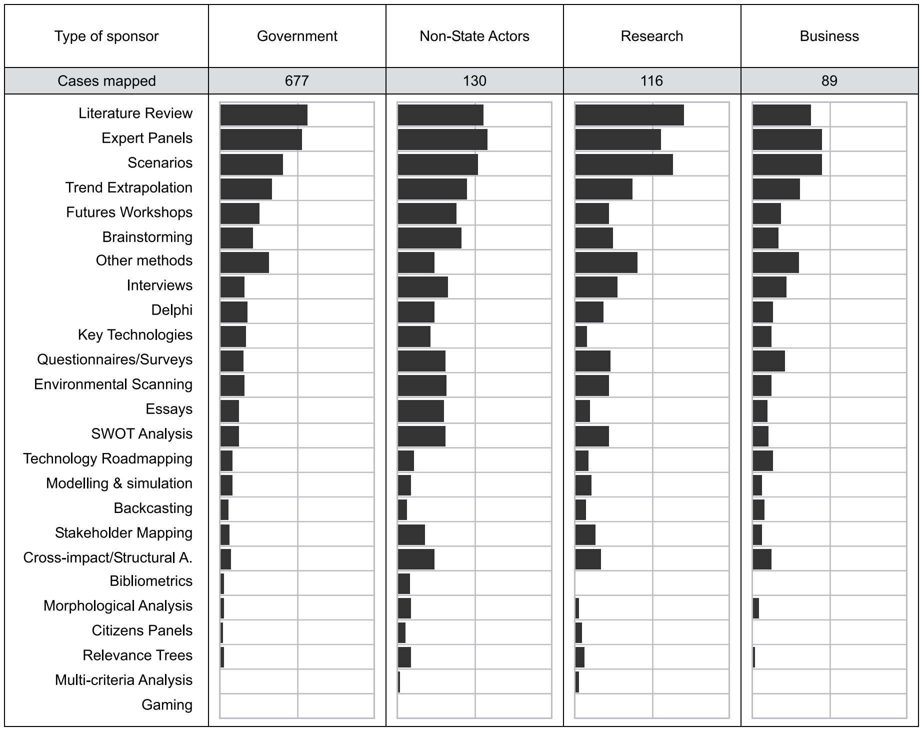
Figure 10 Methods versus time horizon



Note: 759 cases

Sources: EFMN and SELF-RULE (2008)

Figure 11 Methods versus sponsorship



Note: 793 cases. The mapping of sponsorship allows for multiple selections

Sources: EFMN and SELF-RULE (2008)

scope. This is confirmed with the average number of methods used in projects sponsored by the different actors:

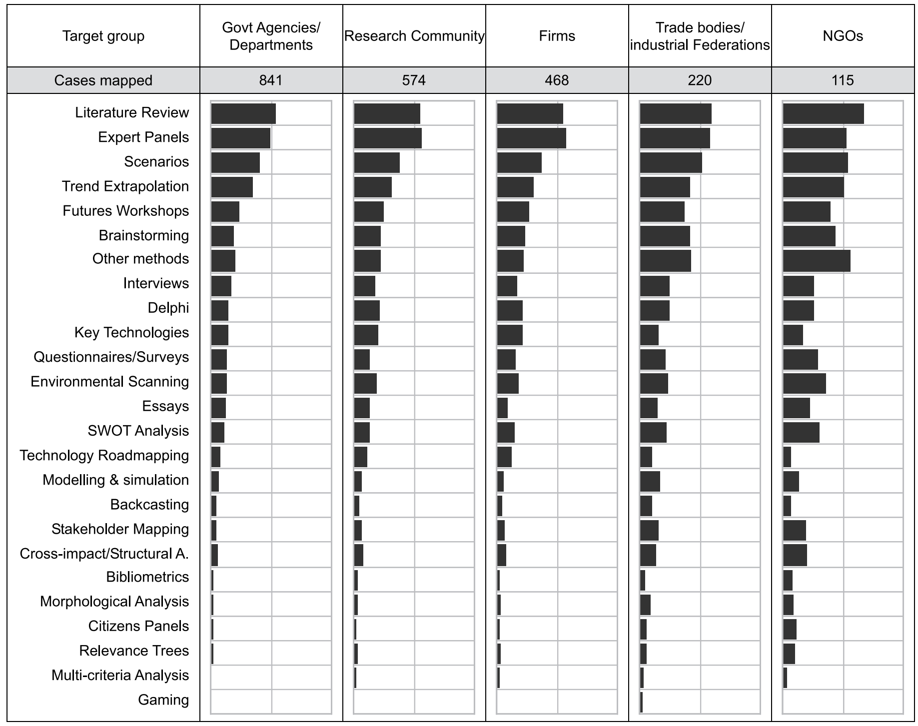
- government (four methods);
- non-state actors (six methods);
- research (five methods); and
- businesses (four methods)

Of course, these numbers provide only a rough indication given that the mapping of sponsorship allows for multiple selections. Other interesting patterns include high the use of LR, mainly in studies sponsored by research, government and non-state actors. One possible explanation for the lower use of LR in businesses is that information for decision making is often needed in pre-packaged and digestible formats, thus making LR unattractive. Finally, the absence of bibliometrics in projects sponsored by research actors is somewhat unexpected. Therefore, the sponsorship influence is somewhat moderate.

3.8 How is selection influenced by the ''target groups''?

Figure 12 shows how methods relate to the target groups of studies. The similarity in patterns for all stakeholders is not a very surprising result, mainly because one of the most common methodological pieces of advice often given to sponsors and organisers is that, regardless of the methods chosen, if the study aims to have an impact on a given science, technology and innovation system, the overall project should target key stakeholders more or less equally. Therefore, one could conclude that potential exclusions of stakeholders in a study are not a matter of methodology but a matter of strategy – or lack of it.

Figure 12 Methods versus target groups



Notes: 886 cases. The mapping of target groups allows for multiple selections

Sources: EFMN and SELF-RULE (2008)

Another result is that networking organisations (e.g. trade bodies and NGOs) have been mainly targeted in projects that have been methodologically demanding, which explains the slightly but consistently bigger size of the bars.

Overall, the influence of the target groups is rather low.

3.9 How is selection influenced by the ''participation scale''?

In foresight, the level of participation is expected to go beyond what is normally achievable in more regular agenda-setting fora*;* however, Figure 13 shows that 210 cases have involved less than 50 people. This could be a measurement effect, given the already mentioned problems of inclusion; or it could be evidence of the different understandings of what foresight really is – a process combining participatory, prospective and policy-making approaches (see also Gavigan *et al.*, 2001)[10]. Other findings include:

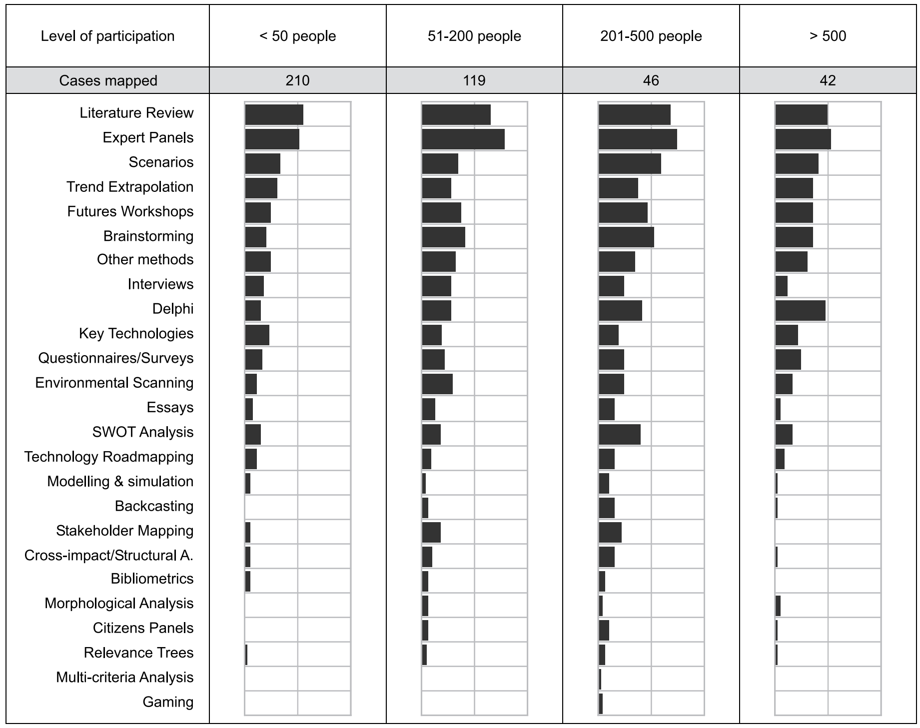
- relatively higher use of expert panels, scanning and stakeholder analysis in cases involving between 50 and 500 people;
- much higher use of scenarios, brainstorming and SWOT in projects with participation levels above 200 people;
- relatively lower use of interviews in projects in very large scale projects; and
- a considerable larger use of Delphi in highly participatory studies.

On the whole, the influence of the participation scale is somewhat moderate.

3.10 How is selection influenced by expected ''codified outputs''?

For cases with common outputs like policy recommendations and analysis of trends and drivers, Figure 14 shows no significant differences in the selection of methods, other than

Figure 13 Methods versus participation scale



Note: 417 cases

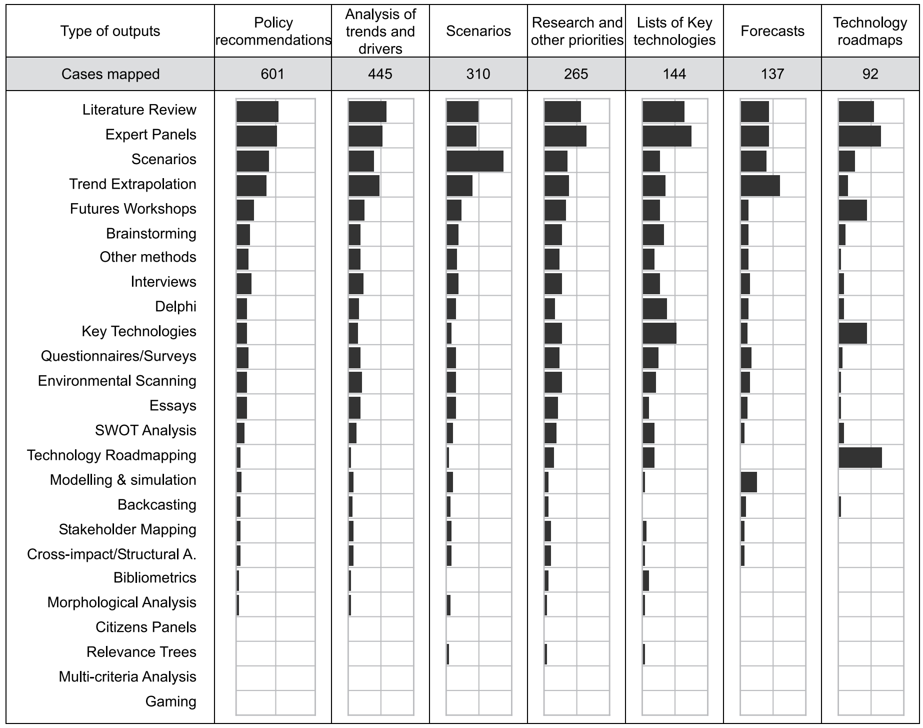
Sources: EFMN and SELF-RULE (2008)

extrapolation being more used for the latter. A similar pattern is found in cases producing scenarios, but with much higher – and obvious! – use of scenarios. In the 265 cases identifying research and other priorities, there is a higher use of LR and expert panels. Interestingly, cases that produce lists of key technologies and roadmaps do not necessarily apply techniques known by these names. This, of course, could be interpreted as a flaw in the mapping; however, experienced practitioners would know – and the results also show – that lists of key technologies can also be produced with expert panels, LR, Delphi, extrapolation, brainstorming and interviews. For instance, the EUFORIA project[11] (see Loveridge *et al.*, 2004) used Delphi in an exploratory way to produce a ''success scenario'' (Miles, 2005) for the European Knowledge Society by 2015. Similarly, technology roadmaps can result from the amalgamation of work using expert panels, LR, futures workshops and key technologies. Finally, extrapolation and modelling are more commonly used to produce forecasts and scenarios (see also Fontela, 2000); and bibliometrics seems to be mainly used to inform recommendations, analysis of trends and drivers, research priorities and lists of key technologies. Thus, overall, the influence of expected codified outputs on methods choice is moderately high.

3.11 How is selection influenced by the ''methods mix''?

To understand the relationships and influence of methods among themselves – the so-called ''methods mix'' – it was necessary to create a methods combination matrix (MCM). This involved crossing the variable methods against itself (originally producing a symmetric matrix) and dividing each row by the respective value in the diagonal which indicates the total number of times a method was used in a sample of 886 cases. The outcome of this operation shows in each cell the proportion in which two methods are combined with respect

Figure 14 Methods versus codified outputs



Notes: 802 cases. The mapping of outputs allows for multiple selections

Sources: EFMN and SELF-RULE (2008)

to the number of times the method on the row was used. Nevertheless, to present results in a more ''digestible'' way, the following categories have replaced the percentages:

- ''L'' for low combinations (i.e. figures below 19 per cent);
- ''M'' for moderate combinations (i.e. 20-39 per cent);
- ''H'' for high combinations (i.e. 40-59 per cent); and
- ''VH'' for very high combinations (i.e. figures above 60 per cent).

Likewise, instead of having ''VH'' or 100 per cent in all cells of the diagonal, the total frequency of use has been included to remind the reader that the levels of combinations are relative to these number of cases (see Figure 15).

Let us now move into the various analyses and interpretations of the MCM. To begin with, the reader should notice that the arrangement of methods is based on their frequency of use (i.e. in the same order as Figure 3). This ranking is displayed on the top row and left-hand side column of the matrix.

As Figure 15 has a significant amount of information, only a few findings will be highlighted here:

- As expected, most methods are highly combined with LR, expert panels and scenarios. So, in order to avoid repetitions, these methods are not mentioned in subsequent highlights – but the reader is advised to keep this in mind!
- Scenarios are also highly used with trends/megatrends extrapolation and moderately used with three other methods.

Figure 15 Methods mix – or methods combination matrix (MCM)

Ranking by frequency of use	Methods Combination Matrix (MCM)	1 Literature Review	2 Expert Panels	3 Scenarios	4 *Trend extrapolation/Megatrends*	5 Futures Workshops	6 Brainstorming	7 Other methods	8 Interviews	9 Delphi	10 Key Technologies	11 Questionnaires/Surveys	12 Environmental Scanning	13 Essays	14 SWOT Analysis	15 Technology Roadmapping	16 *Modelling and simulation*	17 Backcasting	18 Stakeholder Mapping	19 Cross-impact/Structural Analysis	20 *Bibliometrics*	21 Morphological Analysis	22 Citizens Panels	23 Relevance Trees	24 Multi-criteria Analysis	25 Gaming
1	**Literature Review**	477	H	H	H	M	M	M	M		M															
2	**Expert Panels**	VH	440	M	M	M	M		M	M	M															
3	**Scenarios**	H	H	372	H	M	M	M																		
4	*Trend Extrapolation/Megatrends*	VH	VH	VH	223	M	M	M	M		M	M	M	M			M									
5	**Futures Workshops**	VH	VH	H	M	216	M	M			M															
6	**Brainstorming**	VH	VH	H	M	H	169	H	M	M	M	M	M		M											
7	Other methods	VH	H	H	M	H	H	157	M	M	M	M	M		M											
8	**Interviews**	VH	VH	H	H	M	M	M	154			H	M		M											
9	Delphi	VH	VH	M	M	M	H	M		137	M	M	M													
10	Key Technologies	VH	VH	M	H	M	M	M	M	M	133		M		M	M										
11	**Questionnaires/Surveys**	H	VH	H	H	M	M	M	H	M		133	M		M											
12	**Environmental Scanning**	VH	VH	H	H	M	H	VH	M	M	M	M	124	M	M				M							
13	**Essays**	H	H	H	H	M	M	M	M				M	109												
14	**SWOT Analysis**	VH	H	H	M	H	H	VH	M	M	M	M	M		101				M	M						
15	Technology Roadmapping	VH	VH	M	M	H					H					72										
16	*Modelling and simulation*	H	M	VH	VH												67									
17	**Backcasting**	H	H	H	H	M	M		M				M				M	47								
18	Stakeholder Mapping	VH	VH	H	VH	H	VH	VH	H		M	M	VH	M	H				46	M	M	M		M		
19	Cross-impact/Structural Analysis	VH	VH	VH	VH	M	VH	VH	VH	M		VH	VH	M	VH				M	36		M				
20	*Bibliometrics*	VH	H	M	VH	M	H	VH	VH		VH	H	VH	H	H				H		22	M		M		
21	**Morphological Analysis**	VH	VH	VH	H	H	VH	VH	VH	M	M	H	H	VH	M			M	H	H	M	21		H		
22	**Citizens Panels**	H	VH	H	M	VH	H	VH	H	M		M	H	M	H				M	M			19			
23	**Relevance Trees**	VH	VH	VH	VH	VH	VH	VH	VH	M	M	H	VH	VH	VH				VH	M	M	H		17		
24	Multi-criteria Analysis	VH	M		VH	M	M	M	M		M	M	M	M			H								11	
25	**Gaming**	VH	VH	VH	VH	VH	VH			M			H				H	M	VH	M						6

Key: Low (blank); moderate (M); high (H); very high (VH); **bold** = qualitative; *italic* = quantitative; normal = semi-quantitative

Note: 886 cases

Sources: EFMN and SELF-RULE (2008)

- Brainstorming is highly used with futures workshops and moderately used with seven other methods.
- Delphi is highly used with brainstorming and moderately used with seven other methods.
- Key technologies is highly used with extrapolation and moderately used with nine other methods.
- Environmental scanning is highly used with extrapolation and brainstorming and used moderately with eight other methods.
- SWOT is highly used with futures workshops and brainstorming, whereas it is moderately used with eight other methods, for example.

The MCM also shows that some less frequently used methods that require a deeper understanding of the context of a study – such as stakeholder mapping, relevance trees and cross-impact analysis – often use many other methods (probably) to gather relevant and up-to-date information.

More in-depth analysis of the MCM could, without doubt, lead to many other conclusions. Unfortunately, given the space limitation, this paper will not speculate or provide explanations about the patterns shown in each of the 600 cells representing the combination space of the 25 methods used in the mapping.

Instead, the results of a more thought-provoking analysis carried out using three-dimensional mapping tools to visualise the methods mix is presented in Figure 16. The 3D map is a powerful representation of the number and type of linkages between methods. Using different line widths and grey scales to weight relationships, it clearly shows the strength of methods combinations. For instance, the line between expert panels and literature review is not only the widest but also the darkest, meaning that the two methods are very highly (VH) combined. Another fascinating result of this analysis is the elucidation of a sort of family of ''methodological pyramids'' (frameworks), of which the basic and most noticeable structure has LR, expert panels, scenarios, and extrapolation of trends and megatrends at its vertices. Of course, the use of additional or different methods would lead to different methodological ''shapes'' – a potential topic for future research. Other visualisation tools and conceptual frameworks such as the Foresight Diamond could also contribute to a better understanding of the rich but complex information included in the MCM. A targeted example of this is presented in Figure 17, which translates the MCM results for one method – technology roadmapping – into a more comprehensible and logical map of relationships. Based on the above, we can, without doubt, conclude that the influence of the methods mix is very high.

4. Concluding remarks

The findings in section 3 collectively confirm the two hypotheses of this paper: *foresight methods are selected in a (not always coherent or systematic) multi-factor process*. So far this process has been dominated by the intuition, insight, impulsiveness and – sometimes – inexperience or irresponsibility of practitioners and organisers. When Slaughter (2004) suggests that ''it is the depth within the practitioner that evokes depth and capacity in whatever method is being used'', practitioners should also bear in mind that part of this ''depth'' requires the acknowledgement of foresight as a process (Popper, 2008), together with the recognition of the fundamental attributes of methods. In this paper the influence of 11 factors on the selection of foresight methods has been described and analysed objectively in order to avoid – or at least reduce – the typical prescriptive tone of most available literature on the subject. But given the amount of information presented in previous sections, these concluding remarks will only provide a ''snapshot'' of the main findings (see Figure 18):

- The factors most influential in the selection of methods are their *nature* and the *methods mix*. The former shows that qualitative approaches are definitely favoured while the latter shows that some methods go practically hand-in-hand, such as the apparent use of brainstorming as an input for Delphi.

Figure 16 Using 3D mapping tools to visualise the ''methods mix''

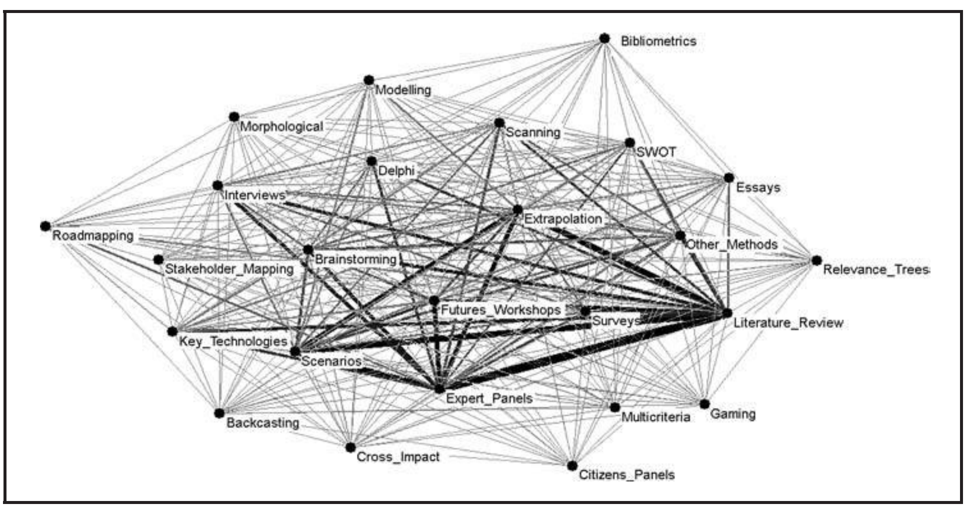


Figure 17 Using the Foresight Diamond to visualise the ''roadmapping mix''

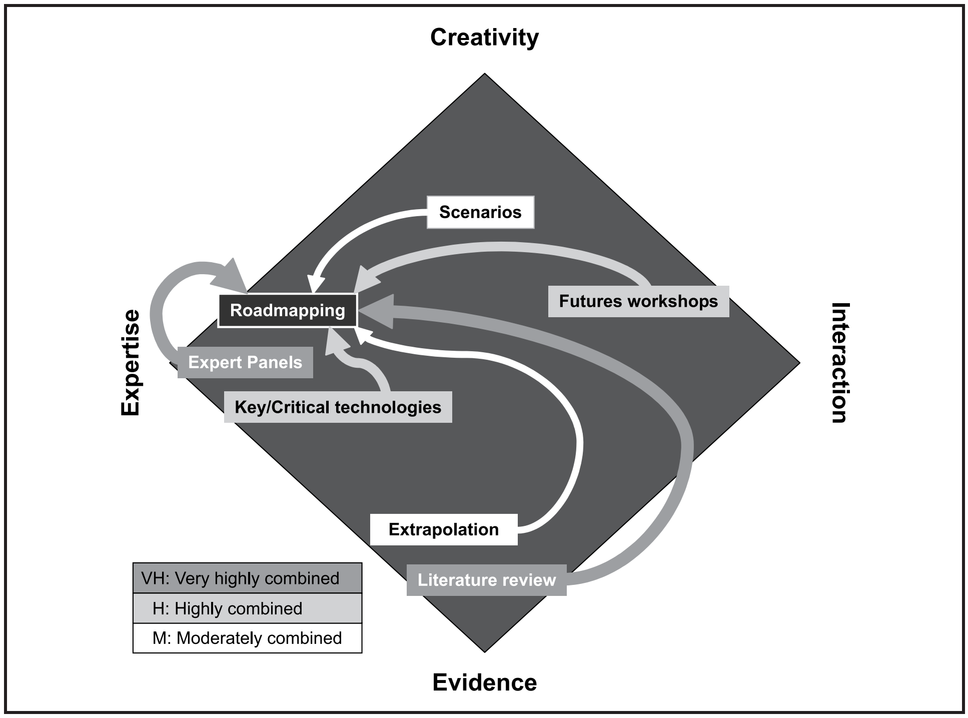


Figure 18 Factors influencing the selection of foresight methods

Attributes of foresight methods		Influence on methods selection: Low	Moderate	High	V-High
Intrinsic nature (i.e. qualitative, quantitative or semi-quantitative)					••••
Capability to gather and process evidence, expertise, creativity or interaction				•••	
Elements of a foresight process		**Influence on methods selection: Low**	**Moderate**	**High**	**V-High**
Pre-Foresight phase	Geo-R&D context			•••	
	Domain coverage	•			
	Territorial scale		••		
	Time horizon		••		
	Sponsorship		••		
Recruitment phase	Target groups	•			
	Participation scale		••		
Generation, Action and Renewal phases	Codified outputs			•••	
	Methods Mix				••••

- Three factors show a relatively high influence: the capabilities of methods – showing a bias towards methods gathering and processing information based on expertise and evidence; the geo-R&D context, showing, for example, that foresight methodologies in lower-R&D contexts tend to be more demanding in terms of number of methods; and the codified outputs, given that some common outputs are largely derived from the use of particular methods (e.g. scenarios, roadmaps and lists of key technologies).
- Four factors show a more moderate influence: territorial scale, where role-related and technical constraints tend to better explain some selections; time horizon, showing, for example, that the use of methods could increase or decrease when the time horizon gets longer; participation scale, revealing that some resource-intensive and participatory approaches (e.g. Delphi) are not very much of a choice in projects with participation levels below 50 people (however, low participation in a study could also be because these methods were not used); and the type of sponsorship, showing, for instance, that studies sponsored by non-state actors are more demanding in scope.

- Finally, factors like the domain coverage and the target groups tend to have low influence on the selection of methods.

Overall the findings have revealed that foresight practices are under-exploiting existing methods based on creativity and interaction. For this reason, the paper would like to conclude with an open invitation to futurists and foresight practitioners to contribute to the development of a more innovative research agenda on the future of foresight methods themselves (Miles *et al.*, 2008) and the balanced promotion of more prospective and participative techniques.

Notes

1. EFMN: European Foresight Monitoring Network; see www.efmn.eu
2. SELF-RULE (Strategic Euro-Latin Foresight Research and University Learning Exchange) is an academic Network (see www.self-rule.org) financed by the European Commission's ALFA Programme under the Cooperation for the Scientific and Technical Training Programme (see Popper and Villarroel, 2006; Villarroel *et al.*, 2007). The network, together with 4-SIGHT-GROUP, launched a mapping initiative in Spanish which initially focused on Latin American foresight and is now being expanded to a more global perspective. The mapping instrument is open to the public and can be accessed at www.4-sight-group.org/mapping
3. The databases have been shaped by previous work carried out by the EUROFORE Pilot Project – a collaborative pilot project between leading foresight institutes in Europe in the European Science and Technology Observatory (ESTO) network (see Keenan *et al.*, 2003). For further info visit the (no longer maintained) project website at: http://prest.mbs.ac.uk/eurofore/
4. The 2005 Gross Expenditure in Research and Development (GERD) for Europe: (in alphabetical order) Austria (2.43 per cent), Belgium (1.82 per cent), Bulgaria (0.5 per cent), Cyprus (0.4 per cent), Czech Republic (1.42 per cent), Denmark (2.44 per cent), Estonia (0.94 per cent), Finland (3.43 per cent), France (2.13 per cent), Germany (2.51 per cent), Greece (0.61 per cent), Hungary (0.94 per cent), Iceland (2.83 per cent), Ireland (1.25 per cent), Israel (4.71 per cent), Italy (1.1 per cent), Latvia (0.57 per cent), Lithuania (0.76 per cent), Luxembourg (1.56 per cent), Malta (0.6 per cent), The Netherlands (1.78 per cent), Norway (1.51 per cent), Poland (0.57 per cent), Portugal (0.8 per cent), Romania (0.39 per cent), Slovakia (0.51 per cent), Slovenia (1.22 per cent), Spain (1.12 per cent), Sweden (3.86 per cent), Switzerland (2.93 per cent), Turkey (0.67 per cent), and the UK (1.73 per cent).
5. Keenan and Popper (2007) have recently produced a practical guide which further discusses these features around four hypothetical processes integrating foresight in research infrastructures policy formulation. See http://prest.mbs.ac.uk/foresight/rif_guide.pdf
6. The data for Latin America is based upon a mapping instrument that includes 33 methods. Some additional methods include benchmarking, genius forecasting, time series analysis, patent analysis, polling/voting, role playing, science fictioning, wild cards and weak signals mapping.
7. For further information on foresight evaluation see Georghiou and Keenan (2005) and Popper *et al.* (2007a, b) or visit www.evaluatingforesight.com
8. Weak signals are ''not necessarily important things'' which do not seem to have a strong impact in the present but which could be the trigger for major events in the future. They often lead to the identification of wild cards, which are surprising and unexpected events with low ''perceived probability'' of occurrence but with very high impact (e.g. a pandemic, tsunami, etc.). Although some researchers have found it vital to examine such events (e.g. Hiltunen, 2006), our methods for identifying and detecting wild cards and weak signals (WI-WE) are still underdeveloped. The reason that most futurists use examples of wild cards to wake up their audiences, but do not then follow through on this, is that there is relatively little that is formalised and reproducible in WI-WE analysis. More conceptual and methodological discussion on these issues are the main research focus of a new 2008-2010 European Commission FP7 project aimed at interconnecting knowledge for the early identification of issues, events and developments (e.g. wild cards and associated weak signals) shaping and shaking the future of science, technology and innovation (STI) in the European Research Area (ERA). More information on the iKnow project at www.iknowfutures.com
9. This reflects the recent penetration of technology watch tools in the region (see Popper and Medina, 2008).

10. For a discussion about the role of participation and bottom-up approaches in foresight within European coordination tools for ''Open Method of Coordination'' (such as ERA-NETs) see Brummer *et al.* (2007).

11. See (no longer maintained) EUFORIA project web site at http://prest.mbs.ac.uk/euforia

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(The Appendix follows overleaf.)

Appendix

Table AI Short description of selected foresight methods

Backcasting	Involves working back from an imagined future, to establish what path might take us there from the present
Brainstorming	A creative and interactive method used in face-to-face and online group working sessions to generate new ideas around a specific area of interest
Citizens panels	A method that brings together groups of citizens (members of a polity and/or residents of a particular geographic area) dedicated to providing views on relevant issues, often for a regional or national government)
Environmental scanning	A method that involves observation, examination, monitoring and systematic description of the social, technological, economic, environmental, political and ethical contexts of a country, industry, organisation, etc.
Essays	A method focused on one or a small set of images of the future, with a detailed description of some major trends promoting the evolution of a particular scenario, and/or of stakeholders' roles in helping to bring these about)
Expert panels	A method that brings together groups of people dedicated to analysing and combining their knowledge concerning a given area of interest. They can be local, regional, national or international
Futures workshops	A method that involves the organisation of events or meetings lasting from a few hours to a few days, in which there is typically a mix of talks, presentations, and discussions and debates on a particular subject
Gaming	One of the oldest forecasting and planning techniques, in that war gaming has long been used by military strategists. It is a form of role-playing in which an extensive ''script'' outlines the context of action and the actors involved
Interviews	Often described as ''structured conversations'' and are a fundamental tool of social research. In foresight they are often used as formal consultation instruments, intended to gather knowledge that is distributed across the range of interviewees
Literature review	Often part of environmental scanning processes. Reviews generally use a discursive writing style and are structured around themes and related theories. Occasionally the review may seek to explicate the views and future visions of different authors
Morphological analysis	A method used to map promising solutions to a given problem and to determine possible futures accordingly. It is generally used to suggest new products or developments and to build multi-dimensional scenarios
Questionnaires/surveys	A fundamental tool of social research and a commonly used method in foresight
Relevance trees	A method in which the topic of research is approached in a hierarchical way. It normally begins with a general description of the subject, and continues with a disaggregated exploration of its different components and elements, examining particularly the interdependencies between them
Scenarios	A method that involves the construction and use of more or less systematic and internally consistent visions of plausible future states of affairs
SWOT analysis	A method which first identifies factors internal to the organisation or geopolitical unit in question and classifies them in terms of strengths and weaknesses. It similarly examines and classifies external factors (broader socio-economic and environmental changes, for example, or the behaviour of competitors, neighbouring regions, etc.) and presents them in terms of opportunities and threats
Cross-impact/structural analysis	A method that works systematically through the relations between a set of variables, rather than examining each one as if it is relatively independent of the others. Usually, expert judgement is used to examine the influence of each variable within a given system, in terms of the reciprocal influences of each variable on each other – thus a matrix is produced whose cells represent the effect of each variable on the others

(*Continued*)

Table AI

Delphi	A method that involves repeated polling of the same individuals, feeding back (occasionally) anonymised responses from earlier rounds of polling, with the idea that this will allow for better judgements to be made without undue influence from forceful or high-status advocates
Key technologies	A method that involves the elaboration of a list of key technologies for a specific industry, country or region. A technology is said to be ''key'' if it contributes to wealth creation or if it helps to increase quality of life of citizens, is critical to corporate competitiveness, or is an underpinning technology that influences many other technologies
Multi-criteria analysis	A method used as prioritisation and decision-support technique, especially in complex situations and problems, where there are multiple criteria in which to weigh up the effect of a particular intervention
Stakeholder mapping	A traditional strategic planning technique which takes into account the interests and strengths of different stakeholders, in order to identify key objectives in a system and recognise potential alliances, conflicts and strategies. This method is more commonly used in business and political affairs
Technology roadmapping	A method which outlines the future of a field of technology, generating a timeline for development of various interrelated technologies and (often) including factors like regulatory and market structures
Bibliometrics	A method based on quantitative and statistical analysis of publications. This may involve simply charting the number of publications emerging in an area, perhaps focusing on the outputs from different countries in different fields and how they are evolving over time
Modelling and simulation	A method that refers to the use of computer-based models that relate together the values achieved by particular variables. Simple models may be based on statistical relations between two or three variables only. More complex models may use hundreds, thousands, or even more variables (e.g. econometric models used in economic policy-making)
Trend extrapolation/megatrend analysis	Among the longest-established tools of forecasting. They provide a rough idea of how past and present developments may look like in the future – assuming, to some extent, that the future is a continuation of the past

About the author

Rafael Popper holds a degree in Economics from the Central University of Venezuela. He is a researcher and lecturer on Technological and Social Foresight at PREST, Manchester Institute of Innovation Research of the University of Manchester. He has worked in the field of foresight since the late 1990s, providing methodological advise and training courses, assembling guidance for foresight practitioners, carrying out studies for various organizations in Europe and Latin America, and conducting reviews and evaluations of foresight exercises and programmes. He co-directs teaching programmes on foresight at the University of Manchester, including postgraduate modules and PREST's long-standing executive short course on foresight. He is regularly invited by national governments and international organizations to advise on their foresight activities. Rafael Popper can be contacted at: rafael.popper@manchester.ac.uk and rafael_popper@yahoo.com

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