Applying Experts Methods in the Selection Procedures of Foresight Development Programs

Sylwester Markusik, Maria Cieśla, Damian Gąska, Stanisław Krawiec, Marek Flekiewicz, Ryszard Janecki
Silesian University of Technology, Faculty o Transport, Katowice, Poland

Foresight method is gaining support around the world as a powerful tool that creates common views on future development strategies. It is characterized by a unique feature, which is the maximum participation of stakeholders and experts. The paper presents examples of the results of research carried out based upon the expert methods of foresight procedures. Special attention was paid to different methods of identification and involvement of experts in implementing the projects. The methodology of foresight projects was brought closer, with particular emphasis on those methods which are based on expert knowledge - such as the Delphi technique, panel discussion, brainstorming, STEEP and SWOT analysis methods, public consultation and the scenarios formulation. The result of foresight exploration based on knowledge of experts is the formation of a wide vision of the future development of economy and technology, which helps to make decisions on an effective, long-term strategy of the government, enterprises and scientific institutions. Key words: experts knowledge, foresight.

1. INTRODUCTION

Commercial enterprises, public institutions and civil society organizations operate in an increasingly competitive and complex external environment. Faster creation and diffusion of technological innovation, the unforeseen consequences of economic, political, demographic, social and cultural decisions cause that the development of future events in a given economic sector depends on a number of mutually interacting factors. Most operators are facing the problem of the identification and selection of the dependent and independent factors. The essence of the correlation establishment, or lack thereof is the ability to at least partially determine the future development directions in the economy. Appropriate solution to these dilemmas, allows policy makers to create a future strategy or organization development policy.

In the example, the ongoing global crisis, as well as before, it was noticed that the forecast scenarios of future events is not a simple matter. Many imperfections of forecasting methods and techniques used in business today were revealed. Perhaps the answer to today's requirements is an active process of predicting the future, which will not only allow to determine possible future events, but also to plan appropriate measures to allow the best use of what will happen in order to minimize the potential risks. This is the definition of foresight actions.

2. PARTICIPANTS OF FORESIGHT TYPE ACTIVITIES

One of the components of the main project objective is to establish medium-and long-term foresight trends of technological change to assist in determining the policies for science, research and education. The key is to initiate a creative collaboration between local governments, industry and research institutions, NGOs, etc. Their work requires the participation of all stakeholders having an impact on the region's development - both government institutions and representatives of industry and academia. The result of their work is to develop a strategic vision for the shape of which

is influenced by many centers, shown schematically in Figure 1 [2].

There are several ways to appoint experts to the foresight projects study. The most frequent one is the nomination and co-nomination, when the person generally regarded as an authority or expert is already involved in the work and suggests specialists in the field. Another method used to invite experts is open recruitment; when any person can declare his own candidacy, and after fulfilling certain criteria becomes an expert of a research panel. Recruitment is open, however it involves some risk – the persons in working group won't have enough knowledge or experience in such ventures.

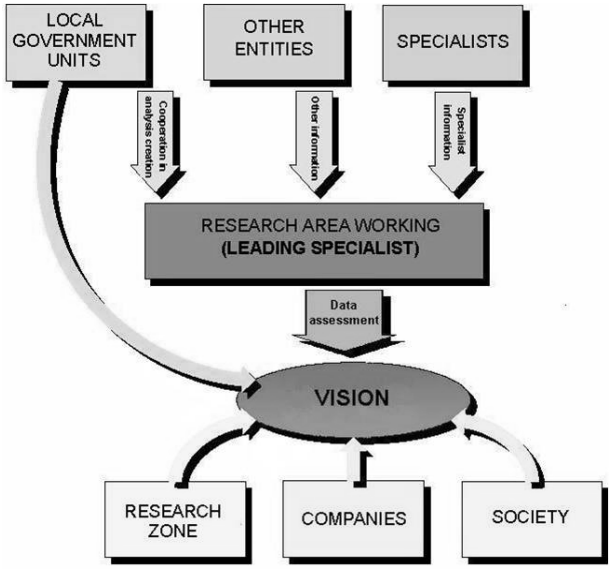

Fig. 1. The interaction between organizations in developing a strategic foresight vision
Source: [2]

The purpose of validating the received opinions from experts, at the nomination of candidates shall be taken into account:

- achievements in research, teaching and organization (according to traditional methods of assessment: a list of publications in the traditional divisions, information about their lectures and training, doctors promoted a list of functions in the system of science, experience in conducting research projects of national and international range),
- experience in interdisciplinary work (list of works and publications of an interdisciplinary character),
- experience in works of innovation and implementation (number of patents, deployment),
- experience in works on forecasting, programming and evaluation of selected fields of science, on the basis of experience presented in such work.

Extremely important to the substance of foresight is the question of cooperation. Such projects necessitate far-reaching cooperation between individuals and institutions that often have nothing in common so far. An additional problem in communication is a very large number of participants involved in research. For example, in a project "Priority technologies for sustainable development of Silesian Province", conducted in 2006-2008, more than 700 people have been involved. In addition to purely technical issues related to communication between the participants in the project foresight, another challenge is the selection of appropriate methodology in the work of specialists. Their ultimate objective is to provide knowledge for groups in a range of decision-making within a specified time for tasks such as to allow comparative analysis between the different thematic panels.

3. FORESIGHT TOOLS

The foresight procedures are available in a wide range of methods, including some specially created for the purpose of predicting the future, while others were borrowed from the techniques of management and planning. Some might not relate specifically to the future, although they are used to lay the foundations for foresight. From the available methods most important is that the specific one should be selected for the purpose for which it is to be used. Exploration of possible, probable and preferred future events takes place on the basis of assumptions about the future, to examine what is the reference to it, which in turn affects the choice of a particular method.

In future studies, which include the foresight and common methods of forecasting, the distinction between exploratory and normative methods fundamental is. This terminology has a solid foundation, but it is rather confusing (since in both approaches, the exploration is done), and there are, some differences between them.

Mining methods are addressed to “the outside”. The starting point is the present study, based on which future analysis is done either based on extrapolation of past trends, or accidental dynamic or by the question "what if " on the implications of possible developments or events. Among the tools used there are trend analysis, impact, the conventional Delphi method. Most forecasting studies have the exploratory nature, but when their effects are alarming predictions, there may be a need to identify the policy turning points, that in turn could be a more desirable future outcomes.

Normative methods are addressed "to the inside. " Their starting point is the initial view of the possible (often desirable) events in the future, or set of events in the future, lie in the area of specific interest. The analysis is done backwards, to allow for the identification of opportunities and how to create future events from the present, the possibility of achieving or avoiding them – having the available restrictions, resources and technologies. Tools used here include various techniques developed for planning processes such as tree links and morphological analysis, as well as less conventional varieties of the Delphi method – "Roadmapping Delphi ". Also recently a method using scenarios of success and "aspirational scenario workshops” have been developed, where participants try to establish a common vision for the future, which is both desirable and credible, and to identify ways in which this can be achieved. There is little evidence which of these approaches: exploratory or normative is more valuable, but in practice the foresight methodology typically includes a mixture of these two.

Systematic construction of medium or long term development vision, its direction and priorities requires the involvement of many parties: entrepreneurs, scientists, government representatives, NGOs and social groups and politicians. For the dialogue between these actors of foresight project, representing the diversity of views in areas close to one another was possible, a whole range of methods for creating, selecting and evaluating such a broad expertise is necessary.

The range of these methods includes:

- methods based on expert knowledge - such as the Delphi technique, expert panel, brainstorming, STEEP and SWOT method analysis, public consultation, the construction of scenarios,
- quantitative methods, based on the analysis of statistical data - extrapolation of trends, modeling, cross impact analysis,
- methods for the identification of key actions - such as key (critical) technologies, relevance trees [1].

The Foresight Diamond includes some 33 methods in terms of the main type of knowledge source on which they are mainly based. These sources of knowledge (creativity, evidence, expertise and interaction) are certainly not fully independent from one other; however, it is possible to use them to highlight the most representative features of each method. Creativity: The mixture of original and imaginative thinking is often provided by technology ‘gurus’, via genius forecasting, back casting, or essays. 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 or wild cards sessions. Expertise: The skill and knowledge of individuals in a particular area or subject is frequently used to support top-down decisions, provide advice and make recommendations. Interaction: Expertise often gains considerably from being brought together and challenged to articulate with other expertise (and indeed with the views of non-expert stakeholders). And given that foresight activities are often taking place in societies where democratic ideals are widespread, and legitimacy is normally gained through ‘bottom-up’, participatory and inclusive activities, it is important that they are not just reliant on evidence and experts. Evidence: 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. Similarly, the diamond emphasizes (fig. 2) the type of technique, using different colors:

- qualitative methods,
- semi-quantitative,
- quantitative.

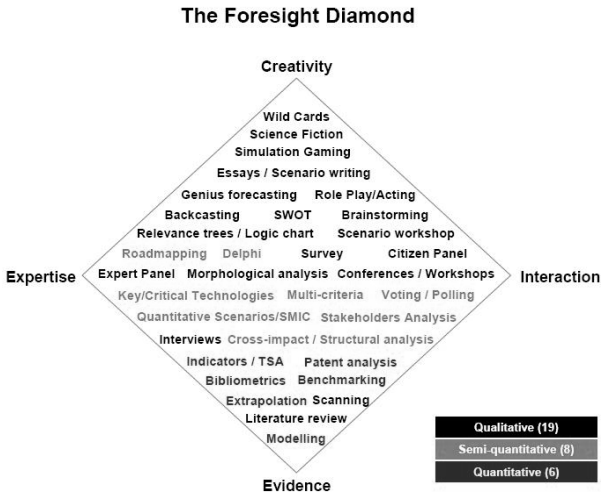

Fig. 2. Foresight diamond

Source: [4]

4. EXAMPLES OF USING THE EXPERT KNOWLEDGE IN FORESIGHT PROGRAMS

An example of the tool based on the expert methodology, assuming evaluation of the problem by an independent expert/experts, which takes into account the influence of external factors on the feasibility of the solution, was to choose one of three options between the integration of two routes in Bytom (between Silesian Agglomeration and Katowice – Pyrzowice Airport) – from Gliwice (route 1) and Tychy (route 2).

The selection criteria were divided because of their importance (attractiveness), and feasibility. Because of the importance of the connection variant: the validity of economic, social, environmental and the ability to create new features for the communication solution, can be taken into account. In addition, as a criterion for feasibility the potential application and implementation of a variant was included. Mappings the specific criteria to the main criteria is shown in fig. 3.

Results of communication variants assessments, assigning appropriate weights for each criterion, the ratings of variants on a scale of 1 to 5 (where 1 means low importance of the criterion, and 5 - high importance), with an average rating of all the experts, are presented in table 1. Such an opinion can be also done on the experts views (e.g. based on an analysis of Delphi), obtained by solving the matrix and averaging the obtained results. If, however criteria for evaluating the different options for communication variants in terms of their usefulness only for the town of Bytom are formulated on the same scale of assessments, their ranking may look different (tab. 2).

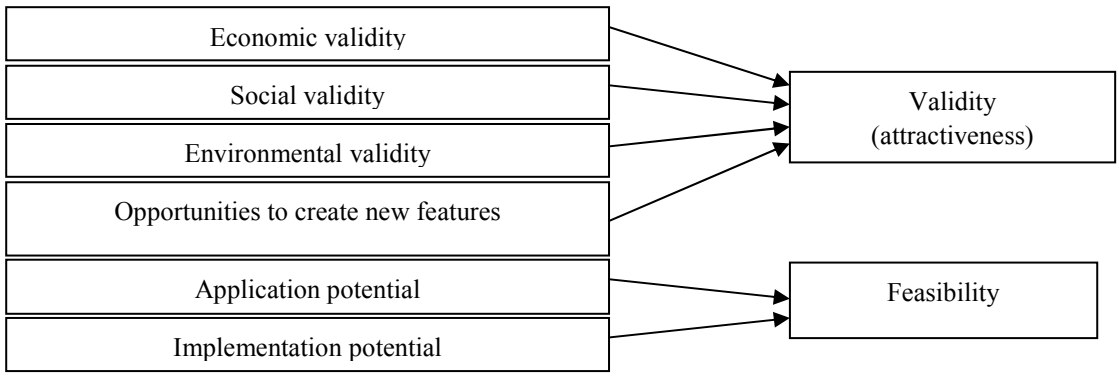

Fig. 3. Criteria for the validity of communications variants

Source: own elaboration [5]

Table 1. The matrix of communication variants assessments

Variant	Criteria for assessing the communication variants						Total points
	Validity			Feasibility			
	Economic	Social	Environment	Opportunities to create new features	Application potential	Implementation potential	
I	4	5	2	5	4	3	23
II	4	3	2	3	3	3	18
III	4	3	1	2	4	3	17

source: own elaboration and [6]

Table 2. Features of usefulness (attractiveness) of the different variants for Bytom

The assessment criterion	Variant I	Variant II	Variant III
Road availability from Bytom and other cities	4	5	2
Attractiveness for trade	5	1	2
City-creation function	5	1	3
Property rights of land	3	2	4
Parking possibilities	4	1	3
Comfort for passengers	5	2	5
The need for investment outlays	2	3	4
Compatibility with the Natura 2000 Program	5	5	3
Environmental impact on the environment (people)	2	3	4
The need for demolition of residential houses	3	1	1
Possibility of realization with PPP program	5	1	2
Possibility of integration with other modes of transport	5	2	2
The possibility of carrying out the required by the railway track radius	4	5	1
Total points	52	32	36
The degree of social expectations fulfillment [%]	80	50	55

source: own elaboration and [5]

With the method presented in tabl.2, evaluation and ranking of the different communication variants of rail routes from Katowice and Gliwice connected in Bytom shows that variant I have great advantages. Viewed from the interests of the town of Bytom Variant III also has many positive features, while vast elimination of Variant II. Despite the subjective evaluation of all three variants of the connection route from the direction of Katowice and Gliwice to Pyrzowice Airport by Bytom, variant I, in which route 1 (from Gliwice) and 2 (from Katowice), are connected in Bytom, seems to be the most favorable, with the highest degree of meeting the expectations of local society.

Another example of the expert knowledge use is the program commenced in 2009 called „Zeroemisyjna gospodarka energią w warunkach zrównoważonego rozwoju Polski do 2050". The aggregation of data from individual fields is done by teams of experts in the field based on a critical analysis of literature and information on the subject. Scanning method will be applied to an environmental or system dynamics. In the case of technological issues the results of the first phase completed in 2007 foresight „Scenariusze rozwoju technologicznego kompleksu paliwowo-energetycznego dla zapewnienia bezpieczeństwa energetycznego kraju" will be used.

The first work stage in technology panel (expert group) was to identify perspective technologies that will allow the development of national energy on the basis of the available energy resources (both renewable and nonrenewable), and meet the requirements of the volume of greenhouse gas emissions. Then the brainstorming method was chosen and it characterized the five criteria for technical and technological evaluation of these technologies (tab. 3). Assigning appropriate weights for each criterion, the ratings of technologies on a scale of 1 to 5 (where 1 means low importance of the criterion, and 5 - high importance), with an average rating of all the experts, are presented in table 4.

Table 3. List of technical and technological criteria

No	Criteria name	Criteria characteristic
I	Environmental validity	Reducing emissions, approaching the zero emissions, or eliminate it completely. Assessing the impact of technology to achieve the desired effect of reducing or eliminating emissions of toxic components, in both: the vehicle maintenance and fuel preparation, manufacture of the vehicle or its components.
II	Social validity	Impact of technology implementation on humans. Multi-faceted assessment of the technology used on humans, in particular health, increase mobility, increase jobs
III	Economic validity	Impact of technology implementation on economic activities. Assessment of how the new technology will affect the company operating the production and trade, or provide the ability to create new businesses, or will change the flow of goods, in particular, the directions of their movement.
IV	Validity of the impact on infrastructure	The assessment of how technology will affect development of urban and rural areas. Will it contribute to their degradation or increase their economic importance?
V	Application potential	The costs of implementing technology and its social importance.

Table 4. Prioritizing of perspective technologies

No	Technology	The criterion for technology assessment (average importance)					Total weighted-average
		I (5,00)	II (4,83)	III (3,50)	IV (3,50)	V (3,67)	
1	power energy-efficient, low emission and zero emission	5,00	5,00	4,33	2,67	4,50	90,17
2	lightweight vehicles technologies	2,83	4,33	3,83	4,00	4,33	78,42
3	reducing the resistance of movement technologies	3,17	4,17	3,17	3,83	4,17	75,75
4	reducing the environmental nuisance technologies	4,50	3,17	3,50	3,00	4,50	77,06
5	Autonomous technologies to optimize vehicle traffic	3,17	3,17	3,00	3,17	3,50	65,56
6	Technologies for reducing the energy intensity of maintenance processes	3,00	4,00	2,83	2,50	4,00	67,67
7	Technologies that increase the sustainability of vehicles	2,67	3,33	2,83	3,67	4,17	67,47
8	Technologies that increase the quality and safety of roads	3,17	3,00	3,33	4,17	3,33	68,81
9	Passive elements of ITS in road infrastructure	2,50	2,50	3,00	4,33	3,67	63,69
10	Intelligent systems for automatic measurement of passenger flows in public transport	2,17	2,17	2,67	4,00	4,00	59,31
11	Intelligent systems for the electronic collection of tolls on public transport	1,83	2,00	2,83	3,50	3,83	55,06
12	Intelligent systems for electronic toll collection for the use of road infrastructure	2,00	2,17	2,67	3,67	3,83	56,69
13	Vehicle Positioning System (satellite navigation)	2,00	2,17	2,83	3,33	3,50	54,89
14	Intelligent traffic control systems	3,00	2,83	3,67	4,33	4,00	71,36
15	management systems in urban public transport	3,00	3,17	2,50	3,33	3,67	64,17
16	Intelligent systems for passenger information	2,17	2,17	2,67	3,00	3,83	55,19
17	sustainable transport technologies for the transfer of cargo from land transport to maritime transport	4,17	4,00	3,67	3,50	3,33	77,47
18	Individualized transport	3,33	3,67	3,83	3,50	2,83	70,44
19	Technologies that use underground areas	3,00	2,33	3,33	4,00	2,50	61,11

Table 5. Perspective technologies ranking based on the expert's knowledge

No	Technology	Total weighted-average
1	**Power energy-efficient, low emission and zero emission**	**90,17**
2	**Lightweight vehicles technologies**	**78,42**
3	**Sustainable transport technologies for the transfer of cargo from land transport to maritime transport**	**77,47**
4	**Reducing the environmental nuisance technologies**	**77,06**
5	**Reducing the resistance of movement technologies**	**75,75**
6	Intelligent traffic control systems	71,36
7	Individualized transport	70,44
8	Technologies that increase the quality and safety of roads	68,81
9	Technologies for reducing the energy intensity of maintenance processes	67,67
10	Technologies that increase the sustainability of vehicles	67,47
11	Autonomous technologies to optimize vehicle traffic	65,56
12	Management systems in urban public transport	64,17
13	Passive elements of ITS in road infrastructure	63,69
14	Technologies that use underground areas	61,11
15	Intelligent systems for automatic measurement of passenger flows in public transport	59,31
16	Intelligent systems for electronic toll collection for the use of road infrastructure	56,69
17	Intelligent systems for passenger information	55,19
18	Intelligent systems for the electronic collection of tolls on public transport	55,06
19	Vehicle Positioning System (satellite navigation)	54,89

Based on the total weighted, a ranking of zero emission (or providing a reduction in CO_2 emission) technologies, taking into account the technical and technological criteria, was achieved. The ranking, on the basis of expert knowledge, include technology:

- power energy-efficient, low emission and zero emission (90.17),
- lightweight vehicles (78.42),
- sustainable transport technologies for the transfer of cargo from land transport to maritime transport (77.47),
- reducing the environmental nuisance (77.06)
- reducing the resistance of movement (75.75)

5. SUMMARY

- The need for the most accurate forecasting results from the uncertainty of the future and the time interval occurring between the time of the decision-making and the consequences arising therefrom.
- Due to the large number of participants in foresight studies it is necessary to use special methods for creating, selecting and evaluating such wide expert knowledge.
- The most commonly used methods based on expert knowledge are: the Delphi technique, panel discussion, brainstorming, method STEEP and SWOT analysis, public consultation, scenarios constructing.
- Heuristic methods make it possible to obtain quantitative evaluation and rankings, even for future data for which current knowledge is incomplete.

BIBLIOGRAPHY

[1] Cieśla M.: Wybór priorytetów technologicznych w transporcie metodą foresight dla województwa śląskiego; Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2009;

[2] Foresight Mazovia; Raport I projektu: Monitorowanie i projektowanie (Foresight) priorytetowych, innowacyjnych technologii dla zrównoważonego rozwoju województwa mazowieckiego; Warszawa, wrzesień 2006;

[3] Koncepcja zintegrowanego dwusystemowego połączenia szynowego AirTrans Aglomeracji Górnośląskiej z Międzynarodowym Portem Lotniczym Katowice-Pyrzowice, Wydział Transportu, Politechnika Śląska, 2005.

[4] Popper R., Keenan M., Miles J., Butter M., Sainz de la Fuenta G.: Global Foresight Outlook GFO

2007. Mapping Foresight in Europe and the rest of the World; The EFMN Annual Report www.efmn.eu

[5] Projekt Foresight: Priorytetowe technologie dla zrównoważonego rozwoju województwa śląskiego, Panel nr 6: „Transport i infrastruktura transportowa", Katowice 2008.

[6] Zintegrowane połączenie Aglomeracji Górnośląskiej z Międzynarodowym Portem Lotniczym Katowice – Pyrzowice; Ministerstwo Gospodarki oraz Urząd Miejski w Bytomiu, 2008