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TECHNOLOGY ASSESSMENT IN FORESIGHT FOR PODKARPACIE PROVINCE TOWARDS REGIONAL INNOVATION POLICY[1]

Key words

Foresight, technology assessment, sustainable development evaluation, methodology, regional innovation strategy, regional innovation policy, Podkarpacie Province

Abstract

Foresight research is an especially useful method for creating regional innovation policy. This is achieved by integrating the instruments for technology assessment with regional foresight and finally utilizing the resulting outcomes in creation of regional innovation strategies.

The aim of this paper is to present the methodology of technology assessment in foresight research realized for Podkarpacie Province to identify priority, eco-innovative technologies, as well as key development directions in innovation policy. The article answers the question on how to use foresight and methods for technology assessment to support the process of regional decision-making on research and innovation policy.

[1] This article is a concise, updated and largely modified version of the text presented by B. Ziolkowski in the year 2010 at the international conference "Sustainable Development Evaluations in Europe, EASY-ECO 2010" in Brussels.

Introduction

The foresight studies are one of many strategic management approaches. They are beneficial for corporate long-term planning as well as regional development planning, including innovation policy.

The first foresight programmes were initiated in Japan by the Science and Technology Agency (STA), which started in 1970 as an initiative to surveying the promising technologies every five years [1]. In Europe, the foresight studies became an important element of national development policy at the beginning of the 1990s [2, 3, 6, 12, 17]. Poland prepared its first national foresight project in the year 2003 and in 2006 started foresight initiatives in regions [19]. It also embraced Podkarpacie Province, which as one of the first regions explicitly included the assessment of technological sustainability into the foresight methodology to identify the priority technologies.

Sustainability assessment methods are regarded as a synonym of sustainable development evaluations, evaluations of/for sustainability or sustainability evaluations [6].

The evaluation approach can be twofold. It is defined as the systematic assessment of the worth of some object, e.g. a program/project/policy [22] as well as an intervention aimed at understanding the situation of the object, modifying it to solve occurring problems and improving its outcomes [6 acc. to 14]. In this paper, the assessment refers to the evaluation of technologies.

The paper aims at presenting the methodology of technology assessment in foresight research realized for Podkarpacie Province (Poland) to identify priority, eco-innovative technologies, as well as key development directions in innovation policy. The article answers the question on how to use foresight and methods for technology assessment to support the process of regional decision--making on research and development policy oriented towards sustainability.

1. The concept of foresight

Foresight exercises also called foresight research, foresight initiatives, foresight efforts, or foresight studies are the process of systematic identification of strategically important areas in science, technology, economy, and society, as well as emerging generic technologies able to boost the socio-economic development [15].

Foresight can be regarded simultaneously as a tool, when it is realized just once or as a process, when its methodology is applied in iterative way (many times) or as a group of many methods used in a sequential order, or one foresight initiative is also a process [26].

There are many criterions for the differentiation of foresight initiatives. The types of foresight are determined by the fact that these studies are realized by companies (corporations) and public bodies, on the local, regional, national,

or international level. According to the traditional specification, there are three types of foresight, i.e.: technological, regional, and regional-technological [24]. Today however, the criterion of policy areas referred to by foresight relates also directly to such fields/types as science, innovation policy, public health, national security, or environment [10]. Moreover, the recent academic concepts also identified such new types of these initiatives as cross-sectoral and cross--departmental foresight [10].

To generate useable results, every foresight exercise should take into consideration a long-term perspective [15] (usually 5-30 years [16]), so in its nature foresight must have a strategic character. For this reason, the expressions as 'foresight' and 'strategic foresight' are exchanged by some researchers [4]. According to other scientists, however, the strategic foresight should be differentiated from other types of these studies, e.g. scientific foresight, industrial foresight, educational foresight, social foresight [20], technology foresight, sectoral foresight, and public function foresight [21]. All the mentioned typologies are an evidence for evolutionary development of foresight theory and practice, which results from the needs of foresight clients. In numerous cases, the aims of one foresight study can relate to many types of needs. As a result, one foresight initiative can be classified into different types; although, in its general character, the foresight can have one strictly defined nature, e.g. regional. An example could be a regional foresight aimed at regional and technological issues, but also strategic, social, scientific, and educational results (Table 1) and consequently constituting some type of multipurpose foresight realized in regions.

Table 1. The aims/needs of some regional foresights in Poland

Region	Aims/needs of foresight
Masovian Province	– Identification of priority technologies of strategic importance for Masovia in the next 20 years – Support for the development of long-term vision for improving the competitiveness of Mazovia and the Warsaw metropolitan region in Europe and globally – Examination of the key directions of sustainable development in the region
Podkarpacie Province	– Analysis of intellectual, social and economic potential of the region in the context of global forecasts and development trends – Identification of development potential in the region and the optimal directions for technical and technological support in Podkarpacie Province – Development of strategic activities in the area of science and technology
Silesian Province	– Building scenarios for development of technology and the identification of key technologies of strategic importance for the sustainable development of the Silesian Province till 2020 – Identifying technological trends to help in the creation of research and education policy – Creating assumptions for a regional system of technological change monitoring

Source: Modified based on [27].

The methods applied in foresight studies are adopted from many social and economic sciences, embracing such classes as the following [8]:

1) Methods based on eliciting expert knowledge to develop long-term strategies: Delphi method, expert panels, brainstorming, mind mapping, scenario analysis workshops, SWOT analysis;
2) Quantitative methods based on statistics and other data: trend extrapolation, simulation modelling, cross impact analysis, system dynamics; and,
3) Methods to identify key points of action to determine planning strategies: critical/key technologies, relevance trees, morphological analysis.

Among the factors determining the foresight usefulness in long-term development policy, A. Havas mentions the following [11]:

1) Globalization, changing environment of competitiveness;
2) Inappropriate usability of sophisticated models used so far without reference to planning and predicting the future;
3) Complex challenges facing the decision-makers, e.g. education and life-long learning, environmental issues, quality of life, competitiveness, regional disparities;
4) Requirement of new skills and behaviours;
5) Growing of clusters, networks and other forms of cooperation;
6) The gap between technological changes and appropriate policies;
7) Intensifying social concerns (ethical and safety) about new technologies;
8) Fading credibility of science;
9) Individualization of citizens and complex decision-making;
10) The need of fundamental rethinking of current policies; and,
11) The need of creating an early warning system on trends.

The benefits achieved after the realization of foresight exercise are dependent on the cooperation of all participating stakeholders (especially management teams and decision-makers [18]). The outcomes of foresight can be effective when it is used as a process and not just as a tool, which requires implementing the foresight procedures into the long-term policy, e.g. regional innovation strategies.

In the next part of the paper, the methodology of technology assessment in foresight project for Podkarpacie Province is presented.

2. Foresight methodology in Podkarpacie Province

The first foresight studies realized in Podkarpacie Province between the years 2006–2008 resulted from a broader, national research program. The leading purpose of the project "Priority technologies for sustainable development in Podkarpacie Province"[2] was the identification and assessment of

[2] Project number WKP 1/1.4.5/2/2006/21/24/602/2006/U, supported by European Found for Regional Development as well as Ministry for Science and Informatization.

future regional development needs as well as the elicitation of the most appropriate technologies and scenarios of the future in the research and development area. The research embraced the phase of the identification of key branches in the region, leading technologies, and priority technologies in the branches [29].

The term of sustainable development introduced into the title of the foresight project was defined as orientation towards activities creating some balance among the three following spheres, i.e. environment, society, and economy. For this reason, the methodology used in the foresight included the impact of technologies on the sustainable development factors.

The range of methods used in foresight for Podkarpacie Province was very broad (Fig. 1).

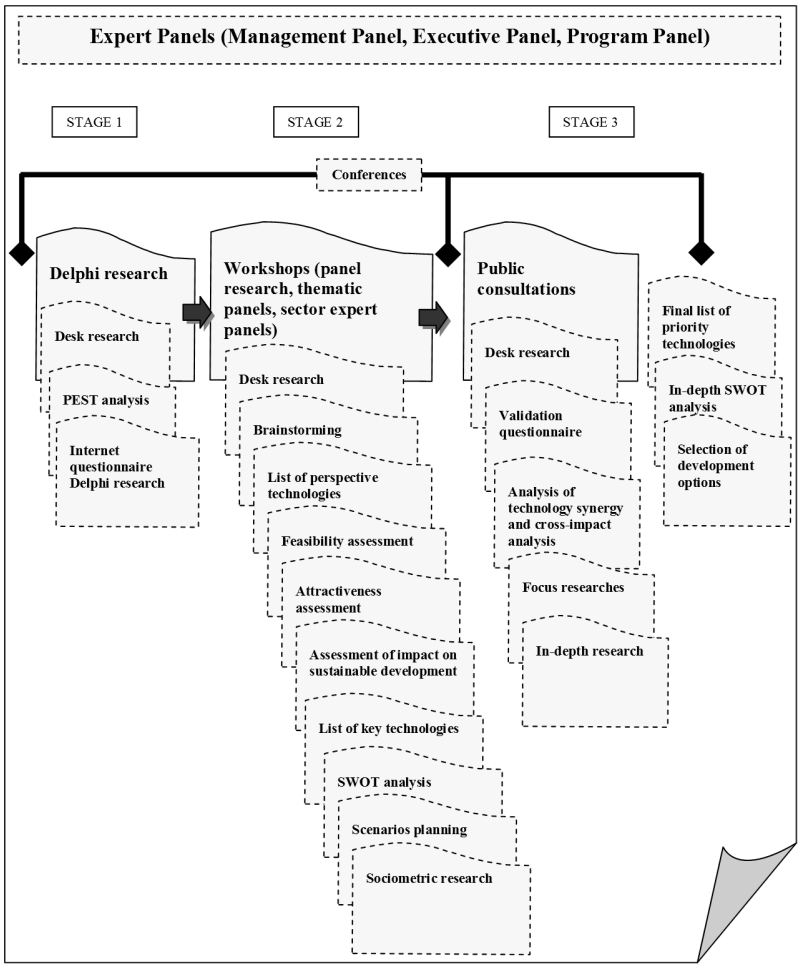

Fig. 1. Methodology of the foresight in Podkarpacie Province from 2006 to 2008 [23]

Each of the methods displayed above deserves a discussion in a separate paper. Nevertheless, according to the aim of this paper, only the methods used for technology assessment will be presented.

The foresight in Podkarpacie identified the lists of perspective, leading, and priority technologies in seven branches.

The first step in the technology assessment process was the formulation of the list of perspective technologies, understood as a group of solutions featured by potential long-term market attractiveness [23]. The list was proposed by experts of each branch panel.

In the next step of technology assessment, there was a list of key/leading technologies defined as a group of solutions featured by the highest attractiveness, feasibility, and impact on sustainable development in every of the seven regional branches [23]. The assessment of the three mentioned factors in every branch panel was formalized and based on the Likert concept (Table 2).

Table 2. The scale of technology assessment in foresight project for Podkarpacie Province

Wages	Technology attractiveness	Technology feasibility	Assessment of impact on sustainable development
5	Very attractive	Definitely feasible	Very important
4	Attractive	Probably feasible	Important
3	May or may not be attractive	May or may not be feasible	Moderately important
2	Unattractive	Probably infeasible	Unimportant
1	Most unattractive	Definitely infeasible	Most unimportant

Source: [28 based on 23].

In case of the assessment of technology attractiveness, the categories put under scrutiny were environmental, social, and economic benefits (Table 3) [25].

Table 3. Interpretation of wages in assessment of technology attractiveness

Wage	Interpretation of wages
	Environmental benefits
5	Shows a positive impact on environment
4	Shows positive impact with potentially minimal negative impact on the environment
3	Shows similarly positive as well as negative impact on the environment
2	Shows negative impact without any positive or with a little positive impact on the environment
1	Show definitely negative impact on the environment
	Social benefits
5	Social benefits are definitely higher than social costs
4	Social benefits are higher than social costs
3	Social benefits are equal to social costs
2	Social costs are higher than social benefits
1	Social costs are definitely higher than social benefits

Wage	Interpretation of wages
	Economic benefits
5	Technology can be definitely legitimate due to the benefits resulting from their use
4	Technology can be legitimate in combination with other technologies
3	Technology can be legitimate in combination with other attractive or highly attractive technologies
2	Technology can be legitimate only in combination with highly attractive technologies
1	Technology cannot be economically legitimate

Source: [25 based on 23].

In order to homogenize the assessment of technology feasibility, the unified interpretation of wages was prepared (Table 4) [25].

Table 4. Interpretation of wages in assessment of technology feasibility

Wage	Interpretation of wages
	Chances for implementation
5	Can be implemented
4	Some researches show that technology can be implemented
3	There are opposite proofs about the possibility for the implementation of technology
2	Some (most) research shows that technology cannot be implemented
1	Lack of possibility for implementation (unfeasible)
	Required R&D efforts
5	No research and development work required (necessary technology is presently available)
4	Some research and development work required (existing technology needs to be expanded and/or adopted)
3	Indeterminable research and development effort needed (existing technology may be inadequate)
2	Major research and development effort needed (existing technology is inadequate)
1	Basic research needed (no relevant technology exists, basic scientific knowledge lacking)
	Resources availability
5	Definitely possible realization of technology within available resources
4	Available resources would have to be supplemented
3	Increase in available resources would be needed
2	Large scale increase in available resources would be needed
1	Unprecedented allocation of resources would be needed
	Existing law and political barriers
5	No major political roadblocks
4	Some political roadblocks
3	Political roadblocks
2	Major political roadblocks
1	Politically unacceptable
	Public acceptance for technology
5	Will be acceptable to general public
4	Some indication this may be acceptable to the general public Public
3	Some indication this may not be acceptable to the general public

Wage	Interpretation of wages
2	Not acceptable to a large proportion of the general public
1	Completely unacceptable to the general public

Source: [25 based on 23].

When compared with other regional foresight projects in Poland, the assessment of impact on sustainable development could be acknowledged as a highly innovative element in the process of priority technologies identification by Podkarpacie. The assessment referred to 40 sustainable development indicators (Table 5).

Table 5. Sustainable development indicators in technology assessment during the foresight in Podkarpacie Province

No	Sustainable development indicators
1	Decrease in energy use
2	Substitution of renewable and inexhaustible resources for non-renewables
3	Change in the structure of fuel consumption towards more environmental friendly fuels
4	Decrease in emission of wastes to the atmosphere
5	Decrease in emission of ozone harmful compounds to the atmosphere
6	Decrease in water consumption
7	Decrease in emission of wastes to water
8	Decrease in amount/positive change in the structure of generated wastes
9	Reclamation of contaminated/degraded areas
10	Increase in the grade of wastewater treatment
11	Increase in the amount of wastes recycling
12	Change in the structure of transit towards being more environmental friendly
13	Support for mass transit, mainly rail transit
14	Support for bike transit
15	Reduction in the length of "travel" (mainly work-housing)
16	Protection and increase in "favourable" biodiversity
17	Increase in the natural and protected areas
18	Protection of surface and underground water
19	Protection and maintenance of soil quality
20	Increase in forest cover and green belts
21	Implementation of environmental management standards
22	Implementation of integrated systems for waste management
23	Development of systems for environmental information
24	Development of systems for environment monitoring
25	Increase in the universality of ecological education
26	Cooperation with non-governmental organizations (NGOs)
27	Higher rate of employment (especially in the sector of services as well as “green” job)
28	Use in consumption in mainly the underground water and improvement in the quality of drinking water
29	Improvement in food “purity” (health)
30	International cooperation for environmental protection
31	Lower amount of toxic substances in production
32	Improvement in monitoring and control of production process

No	Sustainable development indicators
33	Making the industrial processes more effective
34	Need for higher social engagement in the process of technology support (through new taxes and payments)
35	Decrease in the level of noise
36	Increased safety in the workplace
37	More than average increase of the market share thanks to the implementation of technology
38	Improvement in the quality of a product or service
39	Economy of material
40	Shorter production times

Source: [See 23].

Technological sustainability finally determined the selection of the best solutions in the list of leading technologies.

One of the most significant milestones of foresight was the identification of priority technologies defined as a group of solutions featured by the highest attractiveness, feasibility, and impact on sustainable development, which should achieve special support from regional innovation policy [23].

The result of technology assessment referred to the group of perspective and leading technologies, and nine priority technologies have been identified in Podkarpacie Province among seven, primary selected branches. The final selection of priority technologies was a result of integrating outcomes generated in the following stages:

– Branch panels (supported by branch experts),
– Public consultations (performed with social experts), and
– Conference closing the project (supported by experts from management panel).

In the group of methods used during the three mentioned stages of foresight, the technology assessment based on attractiveness, feasibility, and sustainable development was a crucial factor for the creation of the final results. All seven branches also prepared a description of the best leading technologies in the context of their positive and negative impacts.

In the following phase during the public consultations, the generated lists of leading technologies were assessed by experts. They expressed opinions by validation questionnaire on the cross-impact of 44 leading technologies. By means of an enriched version of Boolean logic, the experts assessed the impact of technologies on each other. The scale of attributes applied for the assessment of technological compatibility embraced the following operators:

\+ Compatibility of technology,
─ Incompatibility of technology,
? Uncertainty on compatibility, or
0 The lack of the cross-impact

The information on mutual compatibility was a significant signal on technologies deserving priority support. The next phase of public consultation generated a list of seven technologies that determine the development of other technologies. The public consultation was also a chance to collect the opinions of social experts on the importance of perspective technologies.

The focus interviews (as the next stage of priority technologies identification) aimed at collection of opinions on technology importance expressed by new independent group of social experts. When assessing the contribution by focus interviews, it is remarkable that the role of some technologies were differently assessed than in branch panels.

The conference closing the foresight project created a chance to compare the outcomes after all technology assessments activities performed by branch and social experts. The analysis performed by experts of the management panel generated a list of nine priority technologies for Podkarpacie Province.

The analyses of formulated recommendations after technology assessment allowed one to conclude that the outcomes are an intermediary stage in the process of building the regional sustainable development innovation policy. The next step should be the implementation of foresight methods into the regional management systems (especially in regional and national innovation systems [13]). As a result, the incorporation of eco-innovative technologies into the regional innovation strategies should increase the effectiveness of created policy.

Conclusions

The technology assessment realized during the foresight for Podkarpacie Province generated very useful data for the creation of successful regional innovation policy, especially in the science and development areas. The comparison with other regional foresight studies allows the conclusion that, as one of the first technology assessment of this type in Poland (including assessment of attractiveness, feasibility and impact on sustainable development), the presented research approach integrated numerous foresight methods, including technology evaluation, to support the creation of innovation policy oriented to sustainability.

The results of the foresight project were already implemented into Updated Regional Innovation Strategy for Podkarpacie Province for the years 2005–2013 as well as Regional Innovation Strategy for Podkarpacie Province for the years 2014–2020 towards smart specialisation (RIS3). It needs to be also concluded that the next step – creating the synergy effect in development policy oriented towards the concept of sustainable development innovations – should be the application of integrated foresight and technology evaluation procedures into RIS for Podkarpacie Province.

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Ocena technologii w badaniach foresight dla województwa podkarpackiego na rzecz regionalnej polityki innowacji

Słowa kluczowe

Foresight, ocena technologii, ewaluacja zrównoważonego rozwoju, metodologia, regionalna strategia innowacji, regionalna polityka innowacji, województwo podkarpackie.

Streszczenie

Badania foresightowe są szczególnie przydatną metodą kreowania regionalnej polityki innowacji. Odbywa się to poprzez integrację instrumentów na rzecz oceny technologii z regionalnymi badaniami foresight, a następnie wykorzystanie uzyskanych wyników do tworzenia regionalnych strategii innowacji.

Celem niniejszego artykułu jest przedstawienie metodyki oceny technologii w badaniach foresight zrealizowanych w województwie podkarpackim z zamiarem identyfikacji priorytetowych, ekoinnowacyjnych technologii, a także głównych kierunków rozwoju polityki innowacji. Artykuł odpowiada na pytanie, w jaki sposób wykorzystać metody foresightowe oraz metody oceny technologii, aby wesprzeć proces decyzyjny na szczeblu regionalnym w zakresie polityki badawczo-rozwojowej.