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Application of Enhanced SWOT Analysis in the Future-oriented Public Management of Technology

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Abstract

The main purpose of the paper is to present the rationale, the methodological details and a practical example of the application of the enhanced SWOT analysis in the context of technological foresight. The authors take into account and propose an innovative extension of SWOT analysis by an additional dimension (expanding known in the literature SWOT analysis model that includes three criteria of factor division: occurrence in time, source of origin and nature of influence): the assessment of factor significance in two time perspectives: the current state and the hypothetical horizon. As a result, a thirty-two-field SWOT diagram is obtained. The paper also presents the practical implications of the proposed methodology by offering a case study.

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1. Introduction

The main purpose of the paper is to present the rationale, the methodological details and a practical example of the application of the enhanced SWOT analysis in the context of technological foresight.

SWOT analysis is commonly used in foresight studies as an instrument of categorizing significant factors that determine the development of a particular phenomenon or an organization. In its classical form, SWOT analysis is based on the division of phenomena and states that influence the development of an organization into strengths and

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weaknesses located inside the organization as well as the opportunities and threats located outside the organization [5]. As a result of such division, a four-field SWOT diagram is obtained. An extended SWOT analysis model that includes three criteria of factor division is proposed in the literature [26]. These criteria are: occurrence in time (existing or potential), source of origin (from inside of the system or from the environment), nature of influence (favourable or unfavourable). Such division leads to the creation of an eight-field SWOT diagram. In the opinion of the paper authors, such approach is still insufficient in the context of foresight studies. In foresight projects, SWOT analysis is defined as an analytical tool which should be used for categorizing significant factors that determine the development of a given organization of a territorial entity [6]. When one adopts the foresight approach and aim sat determining the long term visions of the future, the factors that may potentially occur in the future seem to be the most important to study, whereas the already existing factors should be a subject of planning and programming activities with fairly short time perspective. The authors, for the purpose of foresight studies propose an innovative extension of SWOT analysis by an additional dimension: the assessment of factor significance in two time perspectives: the current state and the foresight horizon. As a result, a thirty-two-field SWOT diagram is obtained. The proposed approach constitutes a significant enrichment of foresight methodology. As a result of the proposed enhancement, each group of SWOT factors (strengths, stimuli, weaknesses, counter stimuli, internal opportunities, external opportunities, internal threats, external threats) was additionally split into four fields: factors that are insignificant today and insignificant in the future, factors that are significant today but insignificant in the future, factors that are insignificant today but significant in the future, factors that are significant today and significant in the future [18]. The specificity of foresight research makes one pay special attention to the factors that are of low importance now but may be of high importance in the future. Focusing on drivers which are currently insignificant and are not appreciated by others, but which may lead to a dynamic future growth, is one of the pillars of a good foresight-based strategy [19].

The paper presents the practical implications of the proposed methodology by offering a case study of the application of the enhanced SWOT analysis in the project entitled “Technological Foresight «NT FOR Podlaskie 2020». Regional Strategy of Nanotechnology Development” (NTFOR). SWOT study conducted in the project concerned the possibilities of nanotechnology development in Podlaskie region. The key SWOT factors identified by the experts have been situated in an original time-space framework providing significant strategic information on the conditions for the nanotechnology driven development of Podlaskie region.

Systematizing the drivers generated in the course of the SWOT analysis concerning the nanotechnology development in Podlaskie region allows looking into the future of the region with a broad perspective. It reveals the weaknesses of the region with regards to the possibilities of modern technologies development. At the same time, it points at key success factors. In result, the presented look at the diagnosed factors enables the determination of Podlaskie region’s current strategic position with regards to nanotechnology development and allows charting the most important directions of future action [16].

2. Foundation of SWOT analysis

In general sense SWOT analysis is a two-dimensional analysis that examines both internal and external forces operating on the business that are both positive and negative [13].

SWOT is a commonly conducted analysis in most issue management efforts [20]. It is defined as a comprehensive method used to study the environment of the system (organization, territory, etc.) and analysis of its interior [7]. It constitutes one of the most famous and used strategic planning tools [5]. Its characteristic feature is a multifaceted and dynamic nature and heterogeneity expressed by the existence of multiple mutations functioning in theory and in practice [25]. SWOT procedures apply today not only businesses, institutions and non-profit organizations as well as territorial units. Tools and methods of strategic analysis have been recognized also in the public sector [18].

The name SWOT is an acronym formed from the first letters of words: Strengths, Weaknesses, Opportunities and Threats. It is assumed that the scientific and methodological inspiration to develop assumptions of SWOT analysis was a management technique named Force Field Analysis, developed in the fifties of the twentieth century, by K. Lewin, a pioneer in the field of social sciences [4, 7]. This analysis demonstrates the complexities of the change process and the relationship between the driving forces for positive change and the constraining forces against change [1, 24]. Driving forces promote change, while restraining forces support the status quo [13]. Other sources report that the foundation of a SWOT analysis could also be a LCAG model of Harvard Business School [3].

Classical SWOT procedure involves the detailed identification and classification of all phenomena and states affecting the development of the system. Apply here two criteria. The first is the nature of the effect of actual or potential impact of a factor to the organization, while the second – the wider location factor in terms of organization [26]. The use of these two criteria can distinguish four groups of factors: strengths and weaknesses as well as opportunities and threats. The results based on this method compiled mostly in the table (Fig. 1).

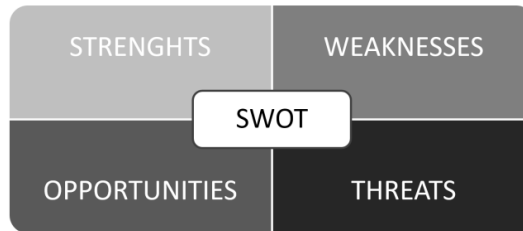


Fig. 1. Diagram of classical SWOT analysis. Source: [8].

It is assumed that the identification of strengths and weaknesses concerns the situation within the organization, while seeking opportunities and threats is an external analysis of the factors [8].

3. Extended SWOT analysis

According to method of strategic analysis of local government territorial entities called SWOT Plus, proposed by A. Sztando [26], factors of development of the system within the four groups of classical SWOT analysis (strengths, weaknesses, opportunities and threats) can be subjected to additional eight categories of classification factors (Fig. 2) [25, 27]:

- Strengths – most importantly, existing at the time of analysis, the properties of the system: active or inactive but it is possible to be activate
- Weaknesses – most importantly, existing at the time of analysis, system properties, which are brakes or barriers to its development
- Internal opportunities – opportunities with great potential, distinctive tested system, stemming from its internal structure
- Internal threats – most importantly, the existing (but for now inactive) properties of analyzed system, which are the brakes of its development internal-system situations with high probability of losing the asset extension
- Stimulants – active external factors contributing to the development of the system
- Counter stimuli – active external factors that are barriers or brakes of system development
- External opportunities – current the most important and potential, positive external factors
- External threats – most negative external factors, the occurrence of which in the projection horizon is highly likely.

		Inside of a territorial system and its features	Environment and factors influencing development in territorial system	Inside of a territorial system and its features	Environment and factors influencing development in territorial system
Unfavourable factors	Favourable factors	STRENGTHS	STIMULANTS	INTERNAL OPPORTUNITIES	EXTERNAL OPPORTUNITIES
	EXISTING FACTORS	WEAKNESSES	DESTIMULANTS	INTERNAL THREATS	EXTERNAL THREATS
			POTENTIAL FACTORS		

Fig. 2. Diagram of SWOT Plus analysis. Source: [3].

The above-described classification of the eight groups of factors is carried out, taking into account the following criteria [18]: 1) The occurrence of a factor at the time: the existing or potential; 2) Their source detailing the interior of the territory and ambient and factors (external) affecting the development of the territory; 3) The type of impact: favourable and unfavourable.

In addition, when creating extended diagram SWOT Plus must take the following types of factors [18]: 1) Existing factors – factors that exist at the moment of the study and currently influencing the analysed system; 2) Potential factors – factors that may have a positive or negative influence on the system in future; 3) Factors originating from the inside of the system (internal) – factors that characterise the activity and resources of the system; 4) Factors from the environment (external) – factors originating from the outside of the system but influencing it; 5) Favourable (positive) factors – factors positively influencing the system, originating either from inside or from outside of the system; 6) Unfavourable (negative) factors – factors negatively influencing the system, originating either from inside or from outside of the system.

4. SWOT analysis in foresight studies

Implementation of foresight projects requires the integration of different research methods [12, 29–31]. A special role is played here the strategic management methods, which includes a SWOT analysis [2, 22].

Research methods used in foresight studies are often ordered using futures diamond, taking into account the four dimensions (representing four sources of knowledge) of foresight methods: creativity, interaction, evidence, expertise (Fig. 3). SWOT represents 3 dimensions: creativity, expertise and interaction with an emphasis on creativity dimension [17].

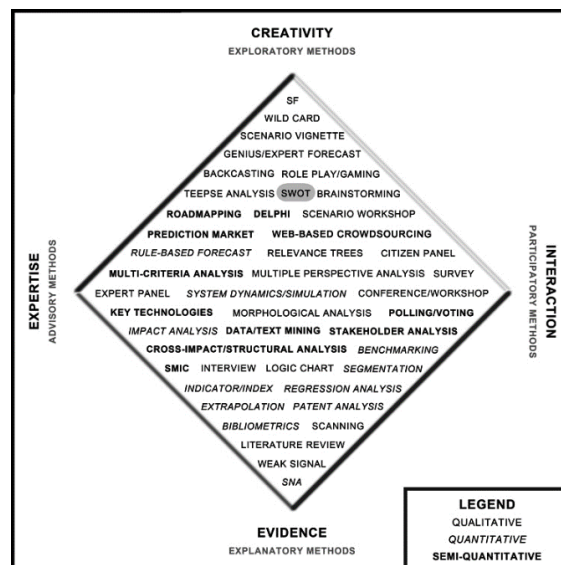


Fig. 3. Positioning SWOT method in futures diamond.

Source: [11].

SWOT analysis in foresight projects is defined as an analytical tool that should be used to categorize the important factors determining the development of different types of phenomena (organizations as company, industry or subdivision as the region or country) [10, 23], making it easier to designate desired most important directions of action [3] or supporting technology assessment [9].

Characteristics of the SWOT analysis in the context of foresight are [23]: i) not a purely foresight approach but a good starting point for the discussion on current and future challenges; ii) organises the results of environmental scan into internal and external issues; iii) good way of mapping out key success factors and vulnerabilities of the studied object; iv) SWOT analysis is scalable, collaborative, integrable, simple and cost efficient.

Interpretation of SWOT analysis from foresight perspective is following [14]: i) most SWOT assessments focus on the current timeframe. It is a major drawback from the strategic point of view. We thus need to provide a forward time frame for SWOT analysis; ii) SWOT analysis with a forward time frame maybe a basis for visionary decisions in management; iii) visionary decisions become appropriate when the situation is assumed to include discontinuities and to be unpredictable in the long term. New skills are needed to reframe and envision the business, and the purposes aimed at are: maintaining excellence of performance and creating novel options, or survival in the long run.

Assessment of the internal environment and the external is an important step in the process of foresight. Internal factors (e.g. industry, company, region or sector) may be classified as strengths and weaknesses, while external factors (e.g. social, economic, technological, and legal, etc.) represent opportunities and threats. It is important that in projects foresight SWOT analysis was carried out by a suitably prepared for this process group of experts using different sources of knowledge [21, 28].

5. Enhancements in SWOT analysis on the example of a real foresight project

In the period 2009-2014 in Podlaskie region was conducted project entitled “Technological Foresight «NT FOR Podlaskie 2020». Regional Strategy of Nanotechnology Development” (NTFOR). It was funded from the Innovative Economy Operational Programme, Priority I. Research and development of new technologies, Measure 1.1. Scientific research support for the development of a knowledge-based economy, Measure 1.1.1. Research projects using the foresight method. The Bialystok University of Technology was the beneficiary of the project, and the Information Processing Centre (OPI) was the Implementing Authority. The project attempted to promote cutting-edge technologies in a situation where traditional industries are not able to ensure the acceleration of the development of the region.

The SWOT analysis (which was one of the main research methods in the project – Fig. 4) related to the Podlaskie Province in terms of nanotechnology development opportunities in that area. The basic technique work of experts was brainstorming.

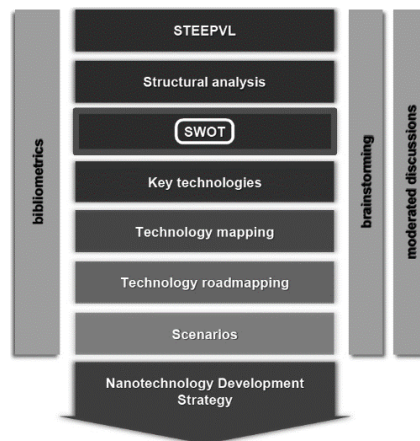


Fig. 4. Methodology framework in project *Foresight technologiczny «NT FOR Podlaskie 2020»*.

The objective of the SWOT analysis was defined as the identification of the determinants of the development of nanotechnology in the region, relating to: 1) Region’s (Podlaskie Province’s) resources were considered as strengths or weaknesses in comparison to other regions; 2) Phenomena in the region’s environment were considered as opportunities or threats for region’s development.

Factors of development of the Podlasie region in nanotechnology identified by experts as part of a classical SWOT analysis were subjected to additional classification in accordance with the assumptions of SWOT Plus analysis presented in the chapter “Extended SWOT analysis” of this publication.

In accordance with the accepted criteria and obtained division into eight categories it agreed the following meanings of individual groups of factors [16]:

- Strengths – factors which have their source within the Podlaskie Province and currently having a beneficial effect on the development of nanotechnology in the Podlaskie Province
- Stimulants – factors which have their source in the vicinity of the Podlaskie Province and currently having a beneficial effect on the development of nanotechnology in the Podlaskie Province
- Weaknesses – factors which have their source within the Podlaskie Province and currently adversely affecting the development of nanotechnology in the Podlaskie Province
- Counter stimuli – factors which have their source in the environment of the region of Podlaskie Province currently adversely affecting the development of nanotechnology in the Podlaskie Province
- Internal opportunities – factors which have their source within the Podlaskie Province and potentially in the future having a beneficial effect on the development of nanotechnology in the Podlaskie Province
- External opportunities – factors which have their source in the vicinity of the Podlaskie Province and potentially in the future having a beneficial effect on the development of nanotechnology in the Podlaskie Province
- Internal threats – factors which have their source within the Podlaskie Province and potentially in the future adversely affecting the development of nanotechnology in the Podlaskie Province
- External threats – factors which have their source in the environment of the region of Podlaskie Province and potentially in the future adversely affecting the development of nanotechnology in the Podlaskie Province.

Further SWOT factors, grouped into eight groups were analyzed by the experts taking into account the results of the evaluation of the factors in 2010 and 2020. This made it possible to assign factors level of importance according to the classification of factor according to the strength of their impact on the development of the region of Podlasie in the field of nanotechnology in 2010 and in 2020.

SWOT factor encompassed four classification criteria, creating a diagram consisting of 32 fields (Fig. 5): 1) factor occurrence in time (existing vs. potential); 2) factor’s origin (internal vs. external) – specification of the interior territory which is Podlaskie, and ambient factors (external) affecting the development of the Podlasie region; 3) factor’s impact (favorable vs. unfavourable); 4) factor significance in time (currently significant vs. significant in the future) – in the perspective of 2010 and 2020 year.

		Inside of a territorial system (Podlaskie province) and its features		Environment and factors influencing nanotechnology development in territorial system		Inside of a territorial system (Podlaskie province) and its features		Environment and factors influencing nanotechnology development in territorial system	
Favourable factors	EXISTING FACTORS	Currently insignificant but Significant in future	Currently significant and Significant in future	Currently insignificant but Significant in future	Currently significant and Significant in future	Currently insignificant but Significant in future	Currently significant and Significant in future	Currently insignificant but Significant in future	Currently significant and Significant in future
		STRENGTHS		STIMULANTS		INTERNAL OPPORTUNITIES		EXTERNAL OPPORTUNITIES	
Unfavourable factors	EXISTING FACTORS	Currently insignificant and Insignificant in future	Currently significant but Insignificant in future	Currently insignificant and Insignificant in future	Currently significant but Insignificant in future	Currently insignificant and Insignificant in future	Currently significant but Insignificant in future	Currently insignificant and Insignificant in future	Currently significant but Insignificant in future
		WEAKNESSES		DESTIMULANTS		INTERNAL THREATS		EXTERNAL THREATS	
		POTENTIAL FACTORS		POTENTIAL FACTORS		POTENTIAL FACTORS		POTENTIAL FACTORS	
		Currently insignificant but Significant in future	Currently significant and Significant in future	Currently insignificant but Significant in future	Currently significant and Significant in future	Currently insignificant but Significant in future	Currently significant and Significant in future	Currently insignificant but Significant in future	Currently significant and Significant in future
		INTERNAL OPPORTUNITIES		EXTERNAL OPPORTUNITIES		INTERNAL THREATS		EXTERNAL THREATS	
		Currently insignificant and Insignificant in future	Currently significant but Insignificant in future	Currently insignificant and Insignificant in future	Currently significant but Insignificant in future	Currently insignificant and Insignificant in future	Currently significant but Insignificant in future	Currently insignificant and Insignificant in future	Currently significant but Insignificant in future

Fig. 5. The classification scheme of factors affecting the development of the Podlasie region in the field of nanotechnology according to the type and extent of the validity of their impact on the development of a territorial unit (division of factors into 32 boxes). Source: [18].

Exemplary list of factors identified in the enhancement SWOT procedures of the project NTFOR is shown in Fig. 6. From the point of view of the implemented foresight actions, which purpose is to define the vision of the future in the long term perspective, important to be seeded SWOT factors with potential to occur in the future.

S1	Academichumanresources
S2	Aspirations of region's population for development
S3	Clean and diverse natural environment of the region
S4	Availability of land for investment
S5	Favourablerelationship between workers qualifications and labourcosts
S6	Privileged position of the region in obtaining European Union funding
S7	Nanotechnology research projects conducted in the region
S8	Strongmedicalindustry
S9	High quality of life in Bialystok

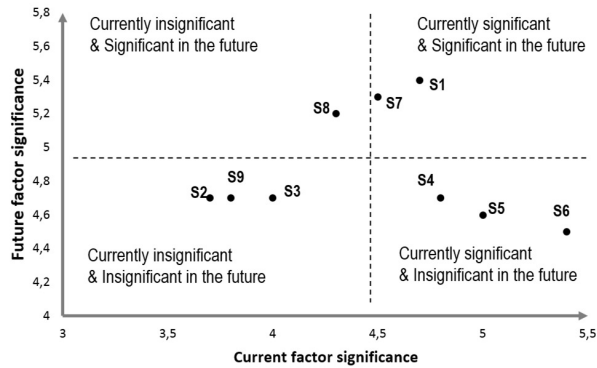


Fig. 6. Selected key factors (strengths) for the purposes of the Podlasie nanotechnology development strategy until 2020.
Source: [16].

Focusing on drivers which are currently insignificant and are not appreciated by others, but which may lead to a dynamic future growth, is one of the pillars of a good foresight-based strategy [19]. In NTFOR project exemplary such factors are: strong medical industry, advanced research in foreign scientific centres, increase in the awareness of the risks resulting from nanotechnology applications. Factors existing now should be the subject of ongoing planning and programming activities, characterized by a relatively shorter time perspective [17].

6. Conclusion

As a theoretical contribution to the field of technology management and engineering management, the authors recommend the enhancement of SWOT analysis taking into consideration the foresight context. By its nature, foresight deals with the – usually distant – future states of reality that cannot be determined by extrapolating past trends.

Experience with the use of enhanced SWOT analysis in real foresight project led to the following conclusions: 1) Extended SWOT analysis allowed extending understanding of current and potential factors that have/may have impact on nanotechnology development in the region; 2) Methodological contribution: extension of SWOT analysis by an additional dimension: the assessment of factor significance in two time perspectives (present and future); 3) As a result, a thirty-two-field SWOT diagram is obtained; 4) Extended SWOT analysis is a valuable strategic tool for an organization or a region; 5) As opposed to typical SWOT (which focuses on the present), extended SWOT pushes your view into the future.

In the NTFOR project enhanced SWOT analysis represented a creativity dimension in assisting of brainstorming method. Regarding to the interaction dimension SWOT analysis next to workshops, structural analysis, surveys, brainstorming allows creating, by all participants – both experts as well as members of the key research team – common ground to create the desired vision of the future development by identifying key and priority nanotechnology. Within the expertise dimension by SWOT method (assisting by expert panels, key technologies, interviews) was possible identification of trends and areas of action for the development of nanotechnology, which made today will allow for the existence of the desired vision of the future, the created in the course of the entire project.

Systematization of factors generated in the NTFOR project in the enhanced SWOT analysis of the Podlasie region in the development of nanotechnology provides an opportunity to look at the future of the region with a broad perspective. It reveals in fact a number of irregularities and shortcomings of the province in terms of the possibility of the development of modern technology, but also indicates the key determinants of success. As a result, a look at the diagnosed factors can determine the current strategic position in the province of Podlasie in the development of nanotechnology, as well as pave the main lines of action in the future.

In conclusion it should be emphasized that the extended SWOT analysis is more suitable for future-oriented studies and may gain popularity in various foresight initiatives.

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