(Extended Abstract)

Application of Structural Analysis to Classification of Technology Development Drivers

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The purpose of the paper is to present the structural analysis as an instrument of identification and classification of factors influencing the development of a particular technology. The paper discusses the theoretical basis of the method and presents its practical implications in the form of a case study of a project entitled "Technological Foresight «NT FOR Podlaskie 2020». Regional Strategy of Nanotechnology Development". The aim of the described project was to find answers to the following questions: What are the key drivers of nanotechnology development in Podlaskie region (Poland) in the perspective of year 2020? What are the interrelations between these drivers? For the research purposes of the article structural analysis was used.

Structural analysis is a tool that allows the detection of a mutual influence and relationship between the drivers of studied system. The first stage of its implementation is to identify the type of interaction between the pair of factors. Applying structural analysis to each pair of A and B factors will yield answers to the following questions: (i) does the A factor have a direct impact on the B factor? (ii) If so, is this impact small, medium, or crucial? For this purpose, it is necessary to determine whether it is direct and what is its strength (low, medium, high or potential). The advantage of the structural analysis is its ability to identify the ties between the variables, whose mutual influences are not obvious and may remain unrecognized even by experts in the field.

By analysing dependencies between ostensibly irrelevant factors, the structural analysis method allows researchers to describe mutual impact, as well as reaction; based on these reactions it is possible to distinguish which variables are crucial [3]. Structural analysis allows one to distinguish the factors that impact on a given research area: crucial factors, which are characterized by large-scale impact and a high degree of dependency on other factors- due to high instability, these factors require critical scrutiny; aim factors, are dependent on other factors and tend to be influenced by such factors rather than vice versa; result factors, are characterized by low impact and high dependency on other factors and are especially susceptible to changes in crucial factors; determinant factors (motorbikes, brakes) have a strong impact on the system, are characterized by a low level of dependency on other factors, and can be regarded as a driving or breaking force; regulatory and supplementary factors are characterized by minimal impact on the system and can prove to be beneficial in achieving strategic goals; external factors are characterized by having a relatively smaller impact on the system than determinant factors, but a greater impact than autonomic variables, and are not impacted upon by

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other variables; autonomic factors are characterized by exerting the least impact on changes taking place in the system as a whole unit [4], [5], [9], [8], [7] (Figure 1).

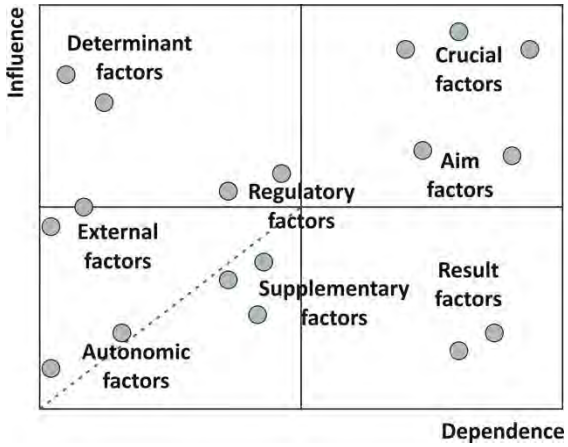

Fig. 1. Arrangement of factors having impact on a given research area – an exemplary result of structural analysis
Source: [8].

Structural analysis can be conducted by utilizing the existing MICMAC computer software, created by M. Godet. The algorithm used in the MICMAC software is based on three fundamental stages:

Stage 1: Determining factors that have influence on the given occurrence.

Stage 2: Describing relations between factors by building matrix and drawing direct and indirect impact graph.

Stage 3: Identifying groups of factors including crucial factors and drawing the influence-dependence chart [1].

Structural analysis within the project *"Technological Foresight <<NT FOR Podlaskie 2020>>. Regional strategy for the development of nanotechnologies"* had a supportive role in the identification of key factors in the development of nanotechnologies: (i) allowed for an alternative classification of the STEEPVL analysis factors, and (ii) substantially supported the process of selecting the key factors for the development of nanotechnology in the Podlaskie Province. The analysis conducted in the framework of the project resulted in the classification of the identified factors according to their significance for the development of nanotechnology in Podlaskie region and in the selection of the factors that are critical to the process. List of factors influencing the development of nanotechnology in the Podlaskie Province is presented in table 1.

Table 1. List of key factors influencing the development of nanotechnology in the Podlaskie Province

Group of factors	Name of the factor
S: social (S)	Human resources potential (S_1)
	Attractiveness of the region for professionals (S_2)
	Social awareness concerning nanotechnology (S_3)
T: technical (T)	Access to the world of nanotechnology (T_1)
	Research and development potential for nanotechnology (T_2)
	Potential applications of nanotechnology in the regional economy (T_3)
E: economic (Ekon)	Regional cooperation networks of entities: science-business-administration ($Econ_1$)
	Expenditure on R & D ($Econ_2$)
	Economic potential of the region ($Econ_3$)
E: ecological (Ekol)	Impact of nanoproducts and nanotechnologies on humans and the environment

	($Ecol_1$)
	State of research in the field of nanotechnology impacts on humans and the environment ($Ecol_2$)
	Activity of environmental organizations and movements ($Ecol_3$)
P: political (P)	State Innovation policy (P_1)
	Regional policy (P_2)
	EU policy (P_3)
V: values (V)	Predominant values (entrepreneurship, health, environment) (V_1)
	Openness to new products, the value of progress (V_2)
	Social interaction, the value of the common good (V_3)
L: legal (L)	Regulations regarding the cooperation between public authorities, business and science (L_1)
	Regulations protecting intellectual property (L_2)
	Legal regulations in the field of nanotechnology (L_3)

Source: [8].

The conducted structural analysis enabled the separation of the key factors exerting a strong influence on other factors and, at the same time, strongly dependent on other factors. Structural analysis, which was based on a matrix of direct impacts, allowed for the identification of four key factors: regional cooperation networks of entities: science-business-administration (Econ1), expenditures on R & D (ckon2), the research and development potential of nanotechnologies (T2) and the human resources potential (S1) (Fig. 2).

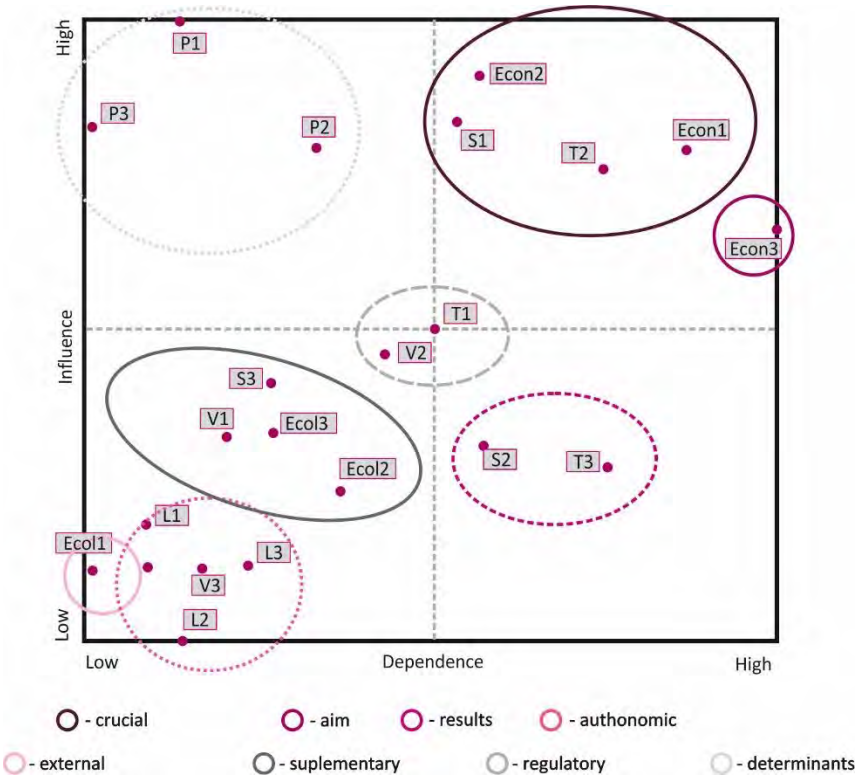

Fig. 2. The division of the factors of the structural analysis, based on direct impacts

Source: [6].

The driving forces of the development of nanotechnologies in the Podlaskie Voivodeship can be considered to include the high research and development potential for nanotechnologies (T2) and efficient regional cooperation networks of entities:

science-business-administration (Econ1). As a result of project works, these factors have been recommended as the axes of scenarios for the development of nanotechnologies in the Podlaskie Voivodeship in the variants: high versus low R & D potential for nanotechnologies, efficient versus inefficient regional cooperation networks of entities: science-business-administration.

Keywords: Structural Analysis, Foresight, «NT FOR Podlaskie 2020», Technology Development

Bibliography:

[1]. Ahmed M.T., Saleh M., Abdelrehim A., El Maghara Scenario A search for Sustainability and Equity: An Egyption Case Study, *Journal of Futures Studies* 2009, 14(2): 55–89. http://www.jfs.tku.edu.tw/wp-content/uploads/2014/01/142-A04.pdf

[2]. Arcade J., Godet, M., Meunier, F., Roubelat, F., *Structural analysis with the MICMAC method & Actors' strategy with Mactor method*. AC/UNU Millennium Project Futures Research Methodology, Paris 1994. http://www.lampsacus.com/documents/MICMACMETHOD.pdf

[3]. Godet M., Durance P., 2008. *La Prospective stratégique, pour les entreprises et les territoires*. Dunod, Paris 2008.

[4]. Godet, M.; Durance, P. 2011. *Strategic foresight. For corporate and regional development*, Paris: Dunod.

[5]. Mazurkiewicz A., Poteralska B., *Zrównoważony Rozwój Polski* [in:] J. Kleer, A. Wierzbicki, Narodowy Program Foresight „Polska 2020". „Dyskusja założeń scenariuszy", Warszawa 2009.

[6]. Nazarko J. (ed.), Brzostowski N., Ejdys J., Glińska E., Halicka K., Kononiuk A., Kowalewska A., Krawczyk-Dembicka E., Łojkowski W., Magruk A., Nazarko Ł., Urban W., Paszkowski J., Pawluczuk A., Skorek A., Wasiluk A., *Podlaska strategia rozwoju nanotechnologii do 2020 roku. Przełomowa wizja regionu [Podlasie nanotechnology development strategy until 2020. Ground-breaking vision of the region],* BUT Publisher, Białystok 2013, http://ntfp2020.pb.edu.pl/pliki/Podlaska-Strategia-Rozwoju-Nanotechnologii-do-roku-2020.pdf.

[7]. Nazarko J.(red.), Wnorowski H. (red.), Kononiuk A. (red.), *Analiza strukturalna czynników rozwoju nanotechnologii w województwie podlaskim [Structural analysis of factors influencing nanotechnology development in Podlaskie Province]*, BUT Press, Białystok 2011, http://ntfp2020.pb.edu.pl/pliki/Analiza_strukturalna_czynnikow_rozwoju_nanotechnologii_w_wojewodztwie_podlaskim.pdf

[8]. Nazarko J. (ed.); Kędzior Z. (ed.). *Uwarunkowania rozwoju nanotechnologii w województwie podlaskim. Wyniki analizy STEEPVL i SWOT [Conditions of nanotechnology development in Podlasie Province. The results of the SWOT and STEEPVL analysis]*. BUT Press, Bialystok 2010, http://ntfp2020.pb.edu.pl/pliki/Uwarunkowania_rozwoju_nanotechnologii_w_wojewodztwie_podlaskim_Wyniki_analiz_STEEPVL_i_SWOT.pdf.

[9]. Popper R., *The French Prospective* in: Handbook of Knowledge Society Foresight ed. by M. Keenan, I. Milesand, J. Koi-Ova. European Foundation, Dublin 2003.