(Extended Abstract)

Combining STEEPVL and Factor Analysis in Identification of Driving Forces of Technology

Joanicjusz Nazarko, Joanna Ejdys, Katarzyna Halicka, Łukasz Nazarko, Anna Kononiuk and Anna Olszewska[1]

Purpose. The purpose of the paper is to present the methodological basis and an example of combining STEEPVL and factor analysis in the identification of driving forces of technology development in foresight studies.

Methodology. STEEPVL analysis is primarily deployed in technological foresight in order to identify external factors (driving forces) influencing the development of a studied technology (Nazarko 2011). It is essentially a heuristic method in which expert knowledge is distilled with help of brainstorming, moderated discussion, surveys and bibliometrics. In the selection of experts for the study, the three-faceted triangulation principle was observed. Firstly, the engaged experts represent diverse professional backgrounds, different genders and ages (expert triangulation). Secondly, engaged experts and information sources used represented various institutions and diverse viewpoints (data triangulation). Thirdly, engaged experts represented diverse research fields (theoretical triangulation) (Kononiuk and Nazarko, 2013).

The study STEEPVL analysis complements the traditional PEST analysis, that locates the driving forces in four distinct fields of the environment (Political, Economic, Social, Technological), with new spheres (Ecological, Values, Legal). The increased number of dimensions allows to grasp potential driving forces that would otherwise be overlooked in case of the traditional PEST analysis. When applied in foresight studies, the results of STEEPVL analysis are typically a basis for constructing scenarios. In such cases, a large number of factors is usually identified in the first stage, after which selection and aggregation follow.

In this paper the authors propose a two-dimensional assessment of STEEPVL factors (drivers) that shape the development of a technology. Theses dimensions are: importance and level of uncertainty (predictability) (Nazarko and Kędzior, 2010). Such assessment allows to eliminate the factors that, according to experts, do not influence the studied technology significantly and/or the factors that are highly predictable and do not have to be explored with foresight tools. The next proposed stage is the factor analysis which aims at reducing the number of analyzed technology development drivers by attempting to group similar (from the point of view of factor analysis) drivers under a one, more comprehensive heading.

Results. The proposed approach allows for the identification of a limited number of the most significant driving forces of technology development. As an example,

[1] Faculty of Management, Bialystok University of Technology, 16-001 Kleosin, Tarasiuk 2 Street, Poland, Tel: +48-784680522, corresponding Author e-mail: j.nazarko@pb.edu.pl

factors affecting the development of nanotechnology in the Podlaskie region (Poland) have been identified and assessed. Altogether sixty-five factors (10 social, 12 technological, 13 economic, 5 ecological, 9 political, 9 values and 7 legal factors) have been initially identified through STEEPVL analysis. Next, those factors have been assessed from the point of view of their importance and the level of their uncertainty. Drivers with values significantly below the arithmetic mean have been excluded from further study. Deployment of factor analysis effected in the further driver aggregation. As a result, 21 main drivers of nanotechnology development in Podlaskie region are obtained (three per each STEEPVL category).

Two factors characterized at the same time by a higher than the average uncertainty rating and a higher than the average importance have been identified. These are: "The potential of nanotechnology applications in the economy of the region" and "The impact of nano-particles and nanotechnologies on humans and the environment". They may be seen as natural candidates for the axes of scenarios of nanotechnology development in Podlaskie region.

However, a more thorough analysis points at factors whose average assessment of the importance and uncertainty only slightly deviates from the mean. Such factors should also be seriously considered in further stages of the project. These factors include: "The state of scientific research on the impact of nanotechnologies on humans and the environment", "Legal regulations in the field of nanotechnology", "The regulations in the field of cooperation between public authorities, businesses and science", "Public awareness of nanotechnologies", "Regulations protecting intellectual property", "Expenditures on R&D", "Innovation policy of the state", "Research and development potential of nanotechnologies" and "Regional cooperation networks of entities: science-business-administration".

The theoretical contribution. The theoretical contribution of the paper to the fields of Technology Management and Engineering Management consists in the significant methodological enrichment of the STEEPVL analysis in the aspects of selection and aggregation (Ejdys, Ustinovičius and Stankevičienė, 2015). The selection is conducted through the three-criteria evaluation of the factors in respect to their predictability, rank (importance) and the extent of influence on the studied phenomenon. In order to achieve the factor aggregation the factor analysis is recommended by the authors.

Practical implications (if applicable). The practical implications of the methodological considerations are presented in the paper in a form a case study describing the combination of STEEPVL and factor analysis in a project entitled "Technological Foresight «NT FOR Podlaskie 2020». Regional Strategy of Nanotechnology Development" (Nazarko, 2013). Recipients of the project's results may be divided into seven categories: a) business, b) higher education and research institutions, c) regional authorities, d) funding bodies, e) business support entities, f) national level institutions dealing with nanotechnology development and g) local media. Different phases of the project generated various outcomes with implications for the groups mentioned above.

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

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