



TECHNOLOGY FORESIGHT: AN INSTRUMENT FOR IDENTIFYING ORGANISATIONAL IMPROVEMENT

Marcin Olkiewicz

Koszalin University of Technology, Faculty of Economic Sciences, Department of Management, Poland

Corresponding author:

Marcin Olkiewicz

Koszalin University of Technology

Faculty of Economic Sciences

Department of Management

St. Kwiatkowskiego 6E, 75-434 Koszalin, Poland

phone: (+48) 94 34 39 116

e-mail: marcin.olkiewicz@tu.koszalin.pl

KEYWORDS

foresight, quality management, investments, technology.

ABSTRACT

The aim of this study is to show that technology foresight can be utilised as an instrument for shaping the future of an organisation. In this paper technology foresight is presented at an organisational level, indicating that each case should be analysed individually while maintaining the methodology and the foresight process. This study also tries to demonstrate that the use of technology foresight can determine the shaping of the quality of an organisation and can potentially become the major driver in its development.

1. Introduction

The management of modern companies requires managers to make quick decisions that will have direct and indirect impact on the conducted processes and the functioning and development of an organisation. The accuracy of decision-making can significantly accelerate or limit the development of various aspects and areas of a company, such as resources, processes, management style, or organisation management. The decision-making process is always accompanied by risk and uncertainty [5, 18]. Therefore, in order to minimise or eliminate the negative consequences of decision making, managers try to use modern management instruments. If done correctly, the process of acquiring information leads to the identification and the analysis of valuable information concerning the potential of an organisation and possible market opportunities.

The implementation of and the skilful application of knowledge of forecasting and planning allows for more effective strategic planning especially when creating a vision of an organisation's future and setting goals. A better understanding of the problems related to the functioning and development of a company, combined with the practical knowledge [14, 25] of achieving intended goals, allows for a more effective implementation of a new system of solutions into the organisation. In order to achieve this, companies are increasingly using foresight. Particularly important is the use of foresight methodologies in production organisations where ade-

quate production processes and stakeholder orientation are key *success factors*. The efficiency of these areas is made conditional on the quality. Therefore, one of the main development goals of a company is the improvement of quality, i.e., within the standardised ISO family management systems.

The use of foresight as a tool for creating the future, an action strategy being the result, is regarded as a determinant of modern management. This article attempts to evaluate the use of foresight methodology as a tool to create directions for organisational development. This is particularly important because the above-mentioned tool is often used by commercial companies. Based on the literature, the use of foresight methodology was indicated and technology foresight was empirically verified.

2. Literature review

Improvement of an organisation is perceived as an action whose aim is to achieve a specific goal by analysing the factors that assist in the ability to reach a goal [38]. Therefore, the process of improvement is considered a strategic element of development. The first stage entails creating the vision of an organisation. The next one involves the use of generated and identified tools to accomplish that vision. Foresight is one of those tools defined as, inter alia, a systematic-participatory process [10, 12], that involves data collection and building

a future development (medium and long-term), whose purpose is to provide the information necessary for the decision-making process and mobilisation for joint action [21].

The interest in foresight methodology [20, 22, 30] has led to a worldwide increase in the implementation of strategic projects [1, 4, 10, 33, 34] including projects in Poland [23, 24]. As a conceptual method, it has been assimilated quite well into various sectors of the economy, increasing the interaction between the world of science and entrepreneurship [15, 27].

Foresight as “futures studies” involves a broad spectrum of activities that covers many aspects of socio-economic and environmental life, including all types of challenges faced by civilisation [7, 13]. In particular, it is used in [11, 31]: social studies, i.e., economics, management, law, administration, education, technical studies, i.e., chemical engineering, energy, infrastructure, architecture, town planning, biotechnology, construction and for strictly scientific purposes, i.e., physics, mathematics, chemistry, geology and biology.

The possible wide use of foresight methodologies allowed the respective literature to distinguish foresight in the context of its application, i.e., international foresight, country foresight, regional foresight, industry foresight, sector foresight, corporate foresight, technology foresight or technology assessment [8, 9, 26].

Technology foresight [15, 17] is a research-driven activity specifically designed for this purpose and developed by experts to indicate key technologies for a particular subject. This allows for a creative exchange of scientific, technical and innovative knowledge which identifies solutions that are accepted by an organisation, and by surveying future stakeholders’ potential needs. It is the process of shaping organisational innovation [16], including where and when significant technological changes are to be initiated and implemented. The benefits of the implemented changes are economic, financial, qualitative and social.

3. Research design

The methodological assumptions and objectives of this study are the result of the author’s interest in the subject of management improvement in terms of the strategic planning of organisational development. The author addressed the following research problems:

P1: Does the use of technology foresight significantly improve quality?

P2: Does the use of technology foresight methodology in strategic planning lead to more effective management?

The research problems and research literature formulated in this manner [3, 35, 37] were the basis for a multi-faceted analysis of thematic blocks in the field of:

- implemented technological innovations,
- quality improvement,
- comprehensive management of an organisation.

The multifaceted and multidimensional nature of the problem made it possible to identify the the research areas as well as to acquire full knowledge on the basis of the internal (technical) documentation of the company, i.e. the qualitative and quantitative data obtained from the performance evaluations and interviews with the organisation’s staff. The study covered a period of 8 years (2008–2016). The subject of the study was a medium-sized electromechanical enterprise employing 80 staff located in the Central-Pomeranian region of Poland.

The usefulness of the adopted research methodology verified the importance of strategic planning utilising technology foresight in achieving, within the framework of improvement, specific quality and efficiency parameters in production which directly influenced the quality of the comprehensive management of the organisation.

4. Case study

Developing an organisation, enhancing its competitiveness, improving quality, increasing the number of stakeholders or increasing customer loyalty constitute a problem for many enterprises in the Central Pomerania region. By utilising foresight methodology, analysing in-depth its current state, and the future possibilities for the company, along with existing mega trends in Europe and in the world, the organisation identified its direction and areas of operation. The primary objective generated by the active participation of the company’s stakeholders was the use of technology foresight as a tool for achieving a vision of the organisation’s future.

Objective achievements were made possible by the simultaneous implementation of activities in three areas: implementation of technological innovations, improvement of quality management, and the responsible management of the organisation especially in the areas of finance and personnel.

Because of the widely conducted methodological foresight actions undertaken by the organisation [31, 32, 36] – qualitative, quantitative and qualitative-quantitative analyses, it was concluded that the main pervasive aspect in all of the results and areas of organisational development was the implementation of changes (improvement). Therefore, the organisation’s improvement is conducted through the action process, in accordance with the development trends of management systems which are focused on quality management of the supply chain [19] and comprehensive quality management [6].

4.1. Method

Such an approach, mainly based on pro-quality activities, forced the researched organisation to, among other things, develop appropriate operational procedures that were in line with international management standards, to determine its R&D activity, and to define the process (mechanism) of risk evaluation, elimination or mitigation.

When analysing the three areas of activity, it should be noted that during the analysed period the organisation:

- a) Quality management perspective:
Implemented ISO 9001, ISO 14001, ISO/TS 16949 and OHSAS 18001 in order to fulfil the requirements and expectations of the stakeholders and worked within an integrated quality management system. By applying the pro-quality policy, the organisation minimized the factors affecting the natural environment, raised the awareness and implemented activities to enhance corporate social responsibility. Moreover, the organisation conducted a more thorough analysis of the needs and expectations of both the market and the stakeholders. It should be noted that pro-quality activities correlated with any changes planned or implemented in the organisation.
- b) Organisational reconfiguration perspective:
among other things, created for their own needs and to meet the expectations of customers, a design office that uses the most modern CAD/CAM software and creates 2D and 3D projects, which are later executed.
- c) Risk management & Information Systems:
minimised the risk based on an integrated IT system that includes: ERP II Graffiti system supporting managing of the production organisations, which includes Enterprise Resource Planning, Production, Quality Control and Accounting) and SAP system with access to relevant customer data, which allows to make and receive orders, invoices and internal documents like Goods Received Note (GRN) and Goods Issued Note (GIN).

From the outset, the path to improvement was focused on the widely defined quality related to all types of creative initiatives in the field of technology investments.

4.2. Results

During the research period, the organisation proactively increased its production capacity by:

- a) expanding its warehouse and production space by 3000 square meters (reaching a total area of 6000 square meters), and is constantly increasing,
- b) purchasing the most advanced production equipment, such as: an AgieCharmilles Wire cutting machine with an accuracy of ± 0.02 mm, MAS MVC 1270 milling machine with ± 0.01 mm accuracy), a CNC type MAS MVC 1270 milling machine with CNC machining capacity up to 1200 kg; a Hexagon Global 7.10.7 coordinate measuring machine capable of measuring $700 \times 1000 \times 700$ mm product dimensions,
- c) purchasing six automated lines SX200, SX300, SMC50 + CR400, SMC50 + CR600, SMC50 + CR850, SMC50 + CR1000, which interact with presses from 160 to 800 tons of slide pressure,
- d) purchasing sixteen one and two-point type presses: LE400, KB3537, KB3539, Erfurt with slide pressure from 250 to 800 tons,
- e) purchasing two FANUC welding robots, a KiMLA laser cutting machine and two modern Vimercati press brakes.

By constantly monitoring and analysing the needs and expectations of the stakeholders, the organisation increased its capability to produce metal parts by utilizing hydraulic and one/two-point eccentric presses, in manual cycle on 38 stripes with pressures from 40 to 1200 tons and 7 production lines operating in automatic cycle with the use of up to 1000 mm width tapes and thicknesses from 0.3 mm to 3 mm, and by offering specialised services, i.e., laser punching, edge bending, welding with machines, manual welding by TIG, MIG, MAG, welding of steel elements including fasteners elements on spot, ticks and inverters welding machines.

Achieving such significant changes required adequate financial resources, as shown in Fig. 1. During the period, 2008–2016, the total value of the organisation's technological investments reached almost eight million zloty.

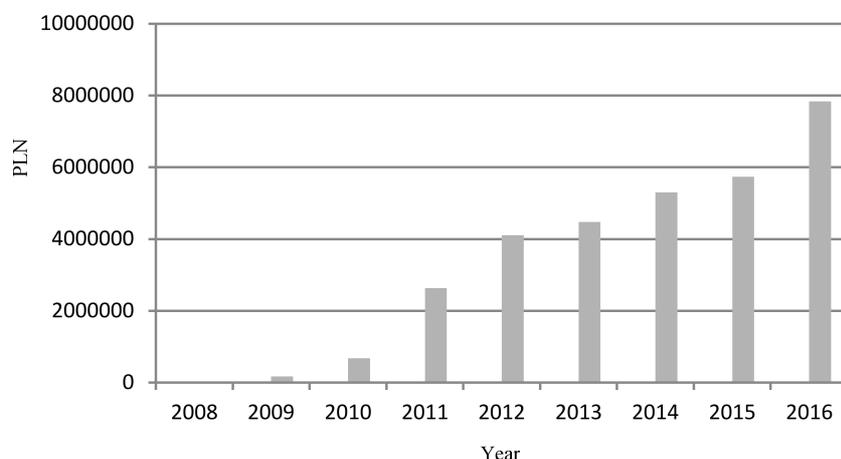


Fig. 1. Amount of infrastructure and technology investment: 2008–2016. Source: own research.

Investments in technology coupled with pro-quality activities within the integrated management system made a significant impact on the company's increased competitiveness, as well as the quality and range of their products and their prices. The increased improvement within the framework of process management was based on the standardised ISO 9001 quality management system. However, as entities were operating, especially automotive stakeholders, the organisation was forced to implement other systems, such as ISO/TS 16949 and ISO 14001. The quality management systems ISO 9001 and ISO 14001 improved the image of the organisation among clients of the two other industries. On the one hand, this was due to the guarantee of the proper functioning of the organisation that ensured repetitive high-quality products and, on the other hand, concern for the environment. The implementation of the environmental management system required the organisation to meet multiple environmental criteria and had a direct impact on the production process. However, sa-

tisfying the needs and expectations of the stakeholders, as part of process-oriented management, and supported by investments that significantly increased production capabilities, allowed the organisation to diversify its automotive components production to include the production of domestic appliances and heating technology products (Fig. 2).

Increasing the production by nearly 267% (Fig. 3) required constant monitoring of the quality of the manufactured goods and services. Therefore, in order to increase the quality control, the double-checking process was introduced to minimise the possibility of non-conformity or defective products. The utilization of the final verification process concluded that the quality parameters of shipped/offered products, which cannot fall below 99% per 100 PPM (parts per million), were not exceeded. The company made the decision to implement the OHSAS 18001 (Occupational Health and Safety Management System) in order to lessen the production of faulty products often due to employee error.

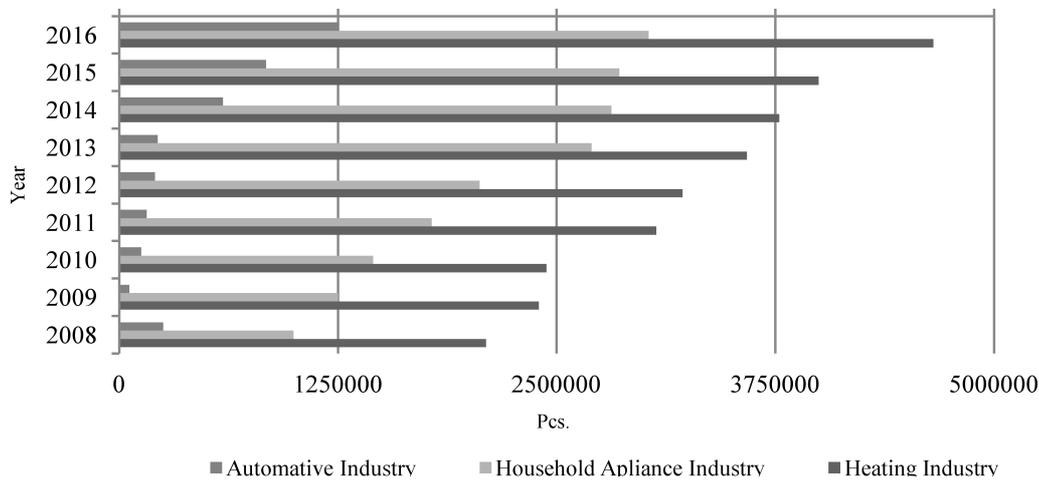


Fig. 2. Volume of production for specific industries: 2008–2016. Source: own research.

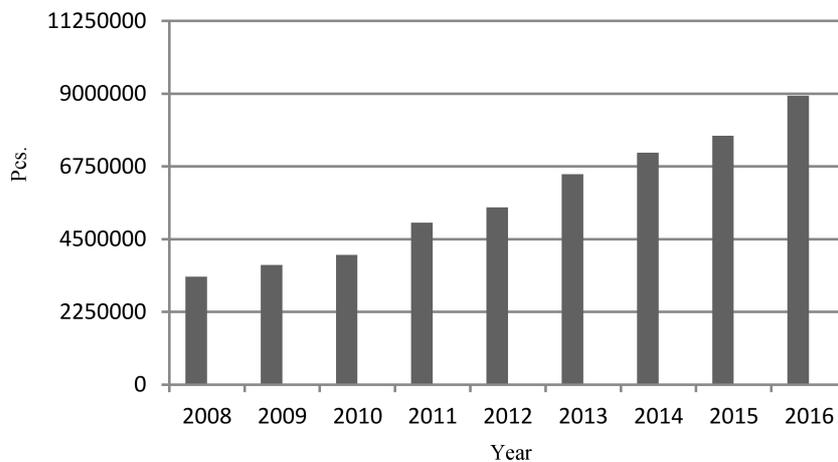


Fig. 3. Total production volume in 2008–2016. Source: own research.

The identification and elimination of errors at individual workstations, as well as continuous surveillance significantly improved the manufacturing process while employing methods to achieve the company's objectives. The process-oriented approach became an important element for the integration of systems which made it possible to change the way quality was perceived and made use of the TQM philosophy. However, when creating the integrated management system it was necessary to appropriately adjust, standardise, and unify the documentation, and to set objective quality parameters along with the means of achieving them. It should be noted that quality, in particular the quality of services, not only depends on the quality of the product, but also on other elements of the supply chain, i.e. the quality of service, timeliness, comprehensiveness, which are also assessed by stakeholders. The current level of the quality parameter is more than 96% (96.41) with the minimum rate of 80%. This is very important because the satisfaction of the stakeholders is always related to the quality of the product, and the analysis and the estimate of their needs and expectations initiate the creation of strategic planning.

This chart illustrates that the search for excellence in all areas of an organisation, particularly in the production sector which constitutes a part of technology foresight, is possible and creates tangible results. It is worth emphasizing that the investments made by the organisation significantly contributed to the increased safety of linear workers (employed in the production department) and to the improvement of their professional qualifications.

5. Discussion

Determining the development of an organisation, which is supported by investments, must be a conscious process of creating the future (vision) with the support of expertise (both practical and scientific), while remaining aware of the stakeholders' expectations. This leads to the generation of optimal directions for defining the strategy of an organisation and to the establishment of an action plan. The applied methodology of foresight for the given organisation indicated that the most appropriate direction of development is technology foresight. The technology-driven management of the company, as defined by technology foresight (in this case study), showed that it was closely linked to the improved quality of the organisation.

The growing interest in technology foresight (strategic technology prediction based on priority technologies) and previous implementations indicated that this process could be used to shape the future of the company. Research confirmed that the use of technology foresight as a process directly influenced organisational development in the following ways [28]:

- improvement of business results,
- increase of organisational effectiveness,

- elimination of interpersonal barriers in the organisation,
- monitoring and continuous improvement of organisational processes,
- improvement of the quality of products and services,
- improvement of management style through standardised management systems
- appropriate use of technology in the company's operations,
- use of outsourcing capabilities to improve the efficiency of the organisation,
- defining the strategic objectives of the organisation, the needs of clients and matching them with the necessary business processes.

The specificity of production organisations, in terms of strategic development, forces companies to improve their resources, processes, quality, management, as the expectations and product requirements of stakeholders continue to rise. That is the reason why organisations are striving to undertake such actions that will guarantee the performance of processes with high parameters of machining accuracy generating high-quality products, both in automated and semi-automatic processes. The implementation of modern technological solutions also requires an appropriate management style for the organisation. This was also the case in the analysed company, which, in order to effectively prepare the organisation for implementing changes, followed international ISO management standards.

Adopting standardisation systemised processes and defined elements of quality improvement within the framework of implemented technological investments. Implementation of the integrated management system had, among other things, minimised the time of individual production processes, ensured batch repeatability and improved product quality. In other words, standardised processes increased production efficiency while retaining the quality and flexibility required by the customer [35].

However, it should be noted that these gains were achieved over the course of several years, and the process of improvement continues to this day. It is important, therefore, to make changes in the organisation in order to anticipate and calculate the potential benefits and threats that affect the development of the organisation and, by minimising or eliminating risks, to increase its value and to identify new challenges.

6. Conclusions, limits, further research

Analysis of the literature and past practices indicate that foresight is an appropriate tool for determining directions for development. The researched organisation demonstrates that the use of technology foresight is an effective tool for planning the development of an organisation. This is confirmed by both the quantitative and qualitative data achieved by the company (Figs. 2 and 3). It is worth noting that this form of creating the future is still "in its infancy" at the enterprise le-

vel. This method is most often used by entities of local government bodies, ministries, and research institutes which is due to the fact that it involves financial capital and is a time-consuming process which many commercial entities cannot afford. From the perspective of the researched organisation, the adopted method seems cost effective. However, although the use of technology foresight and the implementation of generated solutions require significant investment, the results are nonetheless incomparably greater. It should be noted that because of the use of technology foresight the organisation achieved market leadership. Additionally, the adopted development strategy of the company, including the emphasis on quality improvement and stakeholder orientation, should be a starting point for all actions undertaken by organisations. It is important to manage an organisation according to standardised quality management systems. The level of quality and technological advancement attained now has enabled the company to grow its markets, thus becoming a “global organisation” that constantly monitors markets, customer expectations and demands, while conducting research and development activities that create new products and technological solutions.

References

- [1] Açıkgöz A., Günsel A., Kuzey C., Zaim H., *Team foresight in new product development projects*, Group Decision & Negotiation, 25, 2, 289–323, 2016.
- [2] Andersen P.D., Jørgensen B.H., Lading L.B., *Sensor foresight – technology and market*, Technovation, 24, 311–320, 2004.
- [3] Babbie E., *Social research in practice*, Warsaw: PWN, 2007.
- [4] Barker K.E., Cox D., Sveinsdottir T., *Foresight on the future of public research metrology in Europe*, Foresight, 1, 13, 5–18, 2011.
- [5] Bober B., Olkiewicz M., *Chosen aspects of risk management occupational*, UTMS Journal of Economics, 6, 177–184, 2015.
- [6] Bou-Llusar J.C., Escrig-Tena B., Roca-Puig V., *An empirical assessment of the EFQM excellence model: evaluation as a TQM framework relative to the MBNQA model*, Journal of Operations Management, 27, 1, 1–22, 2009.
- [7] Burgelman J.C., Chloupková J., Wobbe W., *Foresight in support of European research and innovation policies: the European Commission is preparing the funding of grand societal challenges*, Business Process Management Journal, 2, 20, 16–22, 2014.
- [8] Butter M., Brandes F., Keenan M., Popper R., *Evaluating Foresight: an introduction to the European Foresight Monitoring Network*, Foresight, 10, 6, 3–15, 2008.
- [9] Calof J., Smith J.E., *Foresight impacts from around the world: a special issue*, Foresight, 14, 1, 5–14, 2012.
- [10] Cuhls K., *From forecasting to foresight processes – new participative foresight activities in Germany*, Journal of Forecasting, 22, 3, 93–111, 2003.
- [11] Ejdys J., Lulewicz-Sas A., *Strategic Foresight as an instrument of shaping future vision of an organisation*, Organisations and Management, 4, 36–42, 2011.
- [12] Farrington T., Henson K., Crews C., *Research foresights. The use and strategic foresight methods for ideation and portfolio management*, Research Technology Management, 2, 26–33, 2012.
- [13] Georghiou L., *Future of foresighting for economic development*, UNIDO Technology Foresight Summit, Budapest, 2007.
- [14] Georghiou L., Harper J., Keenan M., Miles I., Popper R., *The Handbook of Technology Foresight. Concepts and Practice*, Prime Series on Research and Innovation Policy, UK: Edward Elgar, Northampton 2008.
- [15] Georghiou L., Miles I., Popper R., *The Handbook of Technology Foresight: Concepts and Practice*, UK: Edward Elgar, Cheltenham, 2009.
- [16] Gray Ch., *New directions in managing the forecasting process*, Foresight: The International Journal of Applied Forecasting, 31, 50–63, 2013.
- [17] Hideg E., *Theory and practice in the field of foresight*, Foresight, 9, 6, 36–46, 2007.
- [18] Hines A., Bishop P., *Thinking about the future: guidelines for strategic foresight*, Social Technologies LLC, 2006.
- [19] Kaynak H., *The relationship between Total management practices and their effects on firm performance*, Journal of Operations Management, 21, 4, 405–435, 2003.
- [20] Makarova E.A., Sokolova A., *Foresight evaluation: lessons from project management*, Foresight, 16, 1, 75–91, 2014.
- [21] Miles I., Keenan M., *Practical guide to regional foresight in the United Kingdom*, EU: European Communities, Brussels, 2002.
- [22] Nazarko J., *Regional economic foresight. methodology and research*, ZPWiM, Warsaw, 2013.
- [23] Nazarko J., Ejdys J., Gudanowska A., Kononiuk A., Magruk A., Nazarko Ł., Prusiel Ł., *Evaluation study of foresight projects implemented in Poland – Expertise*, Białystok: Białystok University of Technology, 2010.
- [24] Nazarko J., Ejdys J., Kononiuk J., Gudanowska A., Magruk A., Nazarko Ł., *Evaluation study of foresight projects implemented in Poland*, Nazarko J. [Eds.], Warszawa: MNiSW, 2012.
- [25] Olkiewicz M., *Knowledge management as a determinant of innovation in enterprises*, Proceedings of the 9th International Management Conference Management and Innovation For Competitive Advantage, Bucharest, Romania, 399–409, 2015.
- [26] Olkiewicz M., *Models of quality shaping in organisations within the framework of quality foresight*, Koszalin: Koszalin University of Technology, 89–91, 2017.
- [27] Öner M.A., Beser S.G., *Assessment of corporate foresight project results: case of a multinational company in Turkey*, Foresight, 13, 2, 49–63, 2011.

- [28] Palmberg K., *Exploring process management: are there any widespread models and definitions?*, The TQM Journal, 21, 2, 203–215, 2009.
- [29] Pieriegud J., *Use of megatrends to analyse the future development of economic sectors. Megatrends and their impact on the development of infrastructural sectors*, Paprocki W., Pieriegud J. [Eds.], Gdansk: Gdansk University of Technology. 2015.
- [30] Pillkahn, U., *Using trends and scenarios as tools for strategy development*, 1st ed., Berlin-Munich: Publicis Corporate Publishing, 2008.
- [31] Popper R., *Foresight methodology an overview and more*, Bonn, German, 2008.
- [32] Popper R., *How are foresight methods selected?*, Foresight, 10, 6, 62–89, 2008.
- [33] Popper R., Georghiou L., Miles I., Keenan M., *Evaluating foresight: fully-fledged evaluation of the Colombian Technology Foresight Programme (CTFP)*, Pub. Universidad del Valle, Cali <http://community.iknow-futures.eu/pg/file/popper/view/2204/evaluating-foresight-fullyfledged-evaluation-of-ctfp> 2010.
- [34] Saritas O., Burmaoglu S., *The evolution of the use of Foresight methods: a scientometric analysis of global FTA research output*, Scientometrics, International Journal of Innovation Management, 105, 1, 14–24, 2015.
- [35] Sidorova A., Isik O., *Business process research: a cross-disciplinary review*, Business Process Management Journal, 16, 4, 567–595, 2010.
- [36] Silverman D., *The interpretation of qualitative data: methods of analysis call, text and interaction*, Warsaw: PWN, 54, 2008.
- [37] Szreder M., *Methods and techniques opinion research survey*, Warsaw: PWE, 28–41, 2010.
- [38] Turturean C., *Classifications of foresight methods, the year book of the “Gh. Zane”*, Institute of Economic Research, 20, 2, 113–123, 2011.
- [39] Wolniak R., *The assessment of significance of benefits gained from the improvement of quality management systems in Polish organisations*, Quality & Quantity, 47, 1, 515–528, 2013.