4 years in the Łukasiewicz Research Network

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In 2019, under the Act on the Łukasiewicz Research Network, an extensive network was established in Poland, consisting of 38 research and development units operating in various fields of science and concentrated in various parts of the country. The network brings together expert scientific staff (over 4,500 scientists) and manages over 400 laboratories and has specialised research equipment. Currently, 4 years have passed since its establishment, and as a result of optimisation and reorganisation, it consists of 22 institutes. This work presents an overview of the Network's activities and summarises the most important aspects of its activities and identifies mechanisms that allow it to build its position in the scientific community and in the European Research Area.

Keywords – research, network, R&D, institutes, knowledge transfer, project management

Introduction (use Times New Roman, 12, bold, center)

Knowledge-based economy is a concept that emerged in the 1990s, and according to it intellectual capital and knowledge-based resources are the most important development factor [1]. This idea was a reaction to the rapid changes that were taking place in the economy, society, science and technology, as well as their close interconnections affecting the socio-economic life. As it was pointed out: "a knowledge-based economy is an economy in which there are many enterprises that base their competitive advantage on knowledge. Knowledge is that elusive and hard-to-copy company asset that consists of all kinds of useful information that others don't have or know how to use" [2]. Building a knowledge-based economy in Europe is to ensure its competitiveness and a stable position on global markets.

Knowledge-based economy in Poland

In Poland, at the beginning of the 21st century, actions were taken to restructure the organisational forms of the existing research and development units [3], which were aimed at meeting the challenges related to the changing socio-economic environment, Poland's accession to the European Union and the opportunities and threats resulting from the growing global competition. At that time, it was assessed that the key problem of the environment of research and development units in Poland is their fragmentation and, consequently, low efficiency of the conducted activity. In addition, the awareness of consumers and, consequently, entrepreneurs has increased regarding the need to build the position of companies on the basis of high quality services and products provided. Innovations turned out to be the driving force of enterprises, they constituted their market advantage and became a specific tool of entrepreneurship, which is expressed in the constant search for new combinations of production factors and is the engine of economic progress [4]. Many studies show that successful companies are those that create new products, react flexibly to market changes, and introduce innovations in all areas of activity.

According to Spychalska-Wojtkiewicz, the innovation process consists of five phases: basic research, applied research, development work, implementation of innovations and dissemination of innovations in the form of diffusion [5]. Research institutes, unlike universities, focus on applied research and supporting business entities in creating new quality and new solutions or implementing these solutions in specific companies. The benefits of close cooperation between enterprises and research and development units are therefore obvious and translate also into the level of innovativeness of the economy of a given country.

Therefore, in order to increase the intensity of activities in the area of research and development, in 2019, pursuant to the Act on the Łukasiewicz Research Network, the first such extensive network was established in Poland, consisting of 38 research and development units operating in various fields of science and concentrated in various parts of the country. The network brings together specialised scientific staff (over 4,500 scientists) and manages over 400 laboratories and has specialized research equipment. The activity of the Network is oriented around four main areas, i.e. *digital transformation* (*e.g.* automation and robotics, digital agriculture, data science, AI, smart industry, biosensors), *health* (*e.g.* biosensors, innovations in medical technology), *green, low-emission economy* (*e.g.* bioeconomy, new materials and material recovery, green chemistry, sustainable cultivation processes, smart packaging, energy transmission and storage) and *smart and clean mobility* (*e.g.* green construction solutions and components, nanolayers, functional materials and composites, electromobility, smart and green logistics infrastructure, autonomous mobility and network solutions). The purpose of the Network's activity is to create innovative solutions to be used in key sectors of the economy and to inspire the development of entrepreneurship in Poland. This solution was modeled on the organized structures of specialized scientific institutions existing in other European countries [6]. In Germany in 1949 the Fraunhofer Society was created, which currently employs over 25,000 researchers, and the French CARNOT, founded in 2006, is a national multidisciplinary network of over 26,000 employees of research institutes and laboratories. The basis of the activities of these two networks is close cooperation with the industry. This is also the purpose of the Łukasiewicz Research Network, which has been operating now for 4 years. As a result of reorganisation and mergers of units, it currently consists of 22 institutes.

Operating mode of the Network and its accomplishments

During this time, the ‘Łukasiewicz Challenges’ were created, which are an innovative idea for offering the services of Network institutes and establishing cooperation with the business community in Poland. In this mechanism, the customer presents his technological problem, and Łukasiewicz scientists propose a solution to it within 14 days. The long-term effect of this initiative is to support the growth of innovation of business entities operating in Poland and increase their competitiveness, as well as the development and practical use of the research potential of Łukasiewicz's staff working on the latest technologies. The challenges also serve to build cooperation within Łukasiewicz - through a path in which institutes look for other institutes within the Network that have complementary competences and can enrich project consortia. A number of solutions have been introduced to facilitate the commercialisation of solutions developed by researchers. Uniform rules for the protection of intellectual property rights, procedures for financial management or the area of HR and communication are an opportunity for a more proficient organisational level, greater maturity of the organisation. The internationalisation of the Network is currently one of the basic goals of Łukasiewicz's activity. Reinforcement of the staff

with scientists from abroad is intended to increase recognition on the international arena, as well as the effectiveness of obtaining funds from foreign sources, including from the European Union, as part of groundbreaking project initiatives. There are system solutions in the Network, such as a search engine for funding sources, which are available to all employees and collect information about available competitions or calls for projects in one place. There are also competency platforms that bring together representatives of seven different areas crucial for the functioning of the Network from each institute (i.e. organisation, HR, project management, finance, commercialisation, IT, communication), which gives the opportunity to share operating strategies, share good practices and knowledge. Research groups are dedicated to research areas, including representatives of various institutes, which inspire joint activities, consolidate efforts in a given field and help develop the potential of this research.

The most important advantage of the Network is the ability to create the 'effect of scale'. Consolidated activities, such as presence at the world's largest industry events, marketing campaigns, membership in all key area organisations, ensure the ability to influence legislative changes and allow for increased recognition in the European Research Area.

To sum up, the functioning of the Łukasiewicz Research Network, which is the first such ambitious attempt in Poland to consolidate research facilities, certainly enables a more effective coordination of the resources at the disposal of the Network, both competence and infrastructural, enables the creation of a synergy effect and creates the possibility of mutual complementation of the institutes' offer. The high standard of the services offered, which is reinforced by the implementation of uniform operating patterns and procedures and the establishment of functional equivalents at the level of each institute (research director, commercialisation director, etc.), is shaped with respect for the specificity of units, which is important in the context of building an advantage based on diversity and resources diversified historically and in terms of many different domains. Thanks to the challenges system and building project consortia together with entrepreneurs and implementing innovative technologies in companies, the impact of the Network on the economic development of Poland is noticeable. This is evident *e.g.* in the number of innovative project proposals prepared for submission under the financial mechanisms in the new financial perspective of the European Union.

Conclusions

Łukasiewicz Research Network - Institute of New Chemical Syntheses strengthened its position in the Łukasiewicz Research Network, among others, by developing technologies for the bioeconomy in the field of biomass processing, *e.g.* extraction of plant raw materials using supercritical carbon dioxide. This is evidenced by numerous research projects under which supercritical extracts obtained from vertical farms, supercritical extracts with radiation protection properties and supercritical extracts for inhibiting the replication of the most important coronavirus and herpesviruses of poultry and swine and inhibiting of fungal diseases of plant materials are tested. One of the innovative approaches is to replace chemical plant protection products with natural plant extracts from selected plants and to reduce the negative impact of phytopathogens on crops.

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