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DEVELOPMENT OF NEW TECHNOLOGIES IN THE CONTEXT OF THE EU FUNDED PROJECTS IN POLAND

Abstract: *The current EU Multiannual Financial Framework (2014-2020) offers great possibilities for financing development of new technologies. In Poland, the EU money is distributed through Operational Programs managed at central and regional levels. The most important for financing innovations in enterprises is Smart Growth, with the allocation of EUR 8,6 billion. The objective of this paper is to review the main aspects of this Program. Three successful project applications within this program will be analysed as case studies to identify the key success factors in defining innovation and respective R&D activities.*

Keywords: *Operational Program Smart Growth, industrial research, experimental development, innovations, EU projects*

1. INTRODUCTION

Poland became beneficiary of the EU funds in May 2004 (the EU accession). Since then, the country has received a lot of financial support from the European Union. In Poland, the funds are managed at two levels: central level (Ministry of Development) and regional level (Marshalls of 16 voivodships – regions). The money is spent through the so-called Operational Programmes with particular allocation of resources for each of them. In the current EU Multiannual Financial Framework (2014-2020), these are as follows [5]:

- Infrastructure and Environment (EUR 27,4 billion),
- Smart Growth (EUR 8,6 billion),
- Knowledge Education Development (EUR 4,7 billion),
- Digital Poland (EUR 2,2 billion),
- Eastern Poland (EUR 2 billion),
- Technical Assistance (EUR 0,7 billion).

The purpose of the Infrastructure and Environment Program is to support low carbon economy, environmental protection, adaptation to climate change, transport and energy security. It also supports investmenets in the health and cultural heritage [16].

The purpose of the Smart Growth Operational Program is dedicated to entrepreneurs and researchers in order to support the entire innovation process "from an idea to market". It aims to transform ideas into innovative technologies, products and services [18]. It is realized mainly by stimulating research and development and transferring the results to the industry [4].

The Knowledge Education Development Operational Program addresses challenges faced by Europe with relation to globalization, economic development, quality of public policies, demographic issues and human capital. Its major priorities include labour market (e.g. equal access of woman and man to eomployment), poverty, exclusion and social integration (e.g. increasing institutional capacity of social assistance), adaptability of enterprises and employees (e.g. increased competencies of workers), education at different levels (e.g. preparation of students for future employment), good governance (e.g. facilitating access to justice), support for young people (improved job skills and experience), health care system (e.g. better quality of healthcare services), social innovation (e.g. the use of results of innovative projects) [17].

The aim of Digital Poland Operational Program is to strengthen digital foundations for the national development, such as common access to a high-speed internet, effective and user-friendly public e-services and increased level of digital competencies [14].

The Operational Program Eastern Poland is an additional support for five voivodships of Eastern Poland, namely: Lubelskie, Podkarpackie, Podlaskie, Świętokrzyskie, and

Warmińsko-Mazurskie. This macroregion is a consistent area with the lowest level of economic development in Poland and one of the lowest in the European Union. One of the factors affecting socio-economic situation in this macroregion is i.a. its peripheral location on the external border of the EU. The main objective of this program is to increase the competitiveness and innovation of this macroregion by undertaking additional measures to bridge the gaps and dynamise development [15].

The Operational Programme Technical Assistance aims to ensure the efficient functioning of the institutions responsible for implementing the funds, as well as to contribute to the creation of the relevant information and promotion system [19].

Besides, Poland implements the Rural Development Program (EUR 8,5 billion) and Operational Program Fisheries and the Sea (EUR 0,5 billion). All the abovementioned programs are managed at central level. There are also 16 Regional Operational Programs, managed at the voivodhip level, with the allocation ranging from EUR 0,9 billion (Lubuskie region) to EUR 3,47 billion (Silesian region). They all aim to promote smart sustainable and inclusive growth in all regions [5].

As the EU programs are now the main sources of financial support for development of new technologies in Poland, the objective of this paper is to review and explain the Operational Program Smart Growth as the largest national program for financing research, development and innovation in the EU under the Framework 2014-2020. Three successful project applications within this program will be analysed to identify the key success factors in defining innovation and respective R&D activities.

2. OPERATIONAL PROGRAM SMART GROWTH

The Program's lead slogan is "from idea to market" to highlight that it supports the entire innovation process in order to transform ideas into new technologies, products and services. It is the largest national program that finances research, development and innovation in the European Union under the Framework 2014-2020, with allocation of EUR 8,6 billion. It is also the largest program dedicated to enterprises [18].

The creation of innovations requires significant input of labour and funding. However, the expenditure of Polish enterprises on R&D activities is very low and amounts to approx. 25% of the EU average. In the Innovation Union Scoreboard 2016, Poland was placed among moderate innovators, despite poor scores in terms of innovation statistics [6]. The objective of the Smart Growth is to change this situation by encouraging enterprises to spend more money to develop innovative technologies. It will result in creating new jobs and providing innovative products and services on the market, which will increase the competitiveness of the Polish economy.

The Smart Growth is the follow up of the previous Operational Program Innovative Economy 2007-2013, but it is not a simple continuation. The main difference is that in the previous Framework, the most popular form of financial support for enterprises was investment in modern infrastructure. Currently, all financial resources for investments are directed to innovations [9]. New infrastructure is financed to a lesser extent, while in the Innovative Economy Program there were numerous support instruments for infrastructure investment [18].

In the previous program 2007-2013 both researchers and entrepreneurs could apply for subsidies. It is estimated that 16000 companies and 12000 researchers participated in the projects funded within Operational Program Innovative Economy. It led to creation of almost 1400 new technologies and 4700 innovative products and services, for example, the workd's first family and business jet, first electric bus in Europe, a tester for early detection of breast cancer, and a device to establish contact with people in coma. It is predicted that as a result of the Smart Growth Program, at least 12000 companies will receive support for conducting research and development activities and implementing innovations, and it will contribute to the creation of at least 20500 jobs [18].

The Smart Growth program is divided into five areas (measures, also called priority axes) with certain contribution of the EU funds, specifically [18]:

1. Support for R&D activity of enterprises (44,7% of the financial allocation to the Program).

2. Support for the environment and capacity of enterprise for R&D&I activity (12,1%).
3. Support for innovation in enterprises (25,5%).
4. Increasing the research potential (14,2%).
5. Technical assistance (3,4%).

Each of the above measure is further divided into sub-measures, under which the competition announcements (calls for proposals) are published. There are six steps in preparation of application:

- Step 1. Defining the project and appropriate measure (sub-measure).
- Step 2. Finding the appropriate call for proposals.
- Step 3. Studying the conditions of the selected call for proposals.
- Step 4. Praparation and submission of the application form following the instruction and other relevant documentation.
- Step 5. Formal and substantive evaluation.
- Step 6. Signing the co-financing agreement with the relevant Intermediary Institution (in case of the Smart Growth program, these are National Center for Research and Development – NCBR, and Polish Agency for Enterprise Development – PARP, dependent on the measure).

The project can be supported by subsidies, capital instruments, guarantees and loans, dependent on the call for proposals (projects of greatest importance for social and economic development are implemented under the non-competitive procedure). The support can be granted either as refund of expenditure already incurred by the beneficiary, or advance payment for planned expenditure. In the majority of projects, the applicants are required to participate in the costs. The amount of own contribution depends of several factors. The most important ones are type of activities in the project (industrial research or experimental development) and size of the company (small, medium or large). The program also grants bonus (15%) for those who disseminate the results of industrial research and/or experimental development (**Table 1**).

Table 1. Maximum intensity of financial support for research and development activity in enterprises

Status	**Industrial research**	***+ bonus for dissemination***	**Experimental development**	***+ bonus for dissemination***
Micro	70%	*80%*	45%	*60%*
Small	70%	*80%*	45%	*60%*
Medium	60%	*75%*	35%	*50%*
Large	50%	*65%*	25%	*40%*

Source: National Center for Research and Development [12]

It is estimated that in the Smart Growth, EUR 4,4 billion of own contribution will be made by all participating entities. In case of regional programs, own contribution also depends on the regional aid map approved by the Commision [24] and refers to investments in infrastructure.

There are several types of activities that can be financed by the specific measures of the Program, namely: R&D activities to create innovative technologies and products, implementing new solutions on the market, investment in R&D infrastructure, pro-innovation services, entering foreign markets and creating new companies. **Table 2** shows which type of activity can be financed under specific measure/sub-measure of the Program. It includes only competition calls for proposals, while there are also non-competition projects and financial instruments available. However, competition projects are most popular form of obtaining the EU money by Polish enterprises.

Table 2. Support for different types of activities under Smart Growth – competitive measure

Type of activity	**Measures/Sub-measures number and name**
Creating innovation by research and development carried out by the enterprises and consortia	1.1.1 Industrial research and experimental development conducted by enterprises
	1.1.2 R&D work related to manufacturing a pilot/demonstration installation
	1.2 Sectoral R&D programmes for enterprises

	and concortia of enterprises
Implementing new solutions by enterprises	3.2.1 Research for the market
	3.2.2 Technology innovation credit
	3.2.3 Guarantee fund to support innovative enterprises
Investment in R&D infrastructure by enterprises and research institutions	2.1 Support for investment in R&D infrastructure of enterprises
	4.2 Development of modern research infrastructure of the scientific sector
Pro-innovation services by SME and members of Key National Clusters	2.3.1 Pro-innovation BEI services for SMEs
	2.3.2 Innovation vouchers for SMEs
	2.3.3 Internationalization of Key National Clusters
	2.3.4 Protection of industrial property
Entering foreign markets by SME	3.3.3 Support for SMEs in the promotion of Polish product brands – Go 2 Brand
Support for new companies	3.1.5 Support for SMEs to access the capital market – 4 Stock

Source: based on [18].

A vast majority of the above measures is addressed to entreprises, especially to SMEs (micro, small and medium). Only one measure is addressed to scientific sector (4.2) and one to Key National Clusters (2.3.3) (fields in grey in **Table 2**). Thus, enterprises not the scientists have power to decide on the directions of development and implementation of innovative technologies and products. The role of scientific institutions is limited to subcontracting, which allows them to conduct the research and development activities, but the intellectual property rights belong to the enterprise. Scientists can be also employed as R&D personnel in the company's project.

3. INNOVATIONS IN THE CONTEXT OF NATIONAL AND REGIONAL SMART SPECIALIZATIONS

Innovations and related processes are one of the key areas of research that have been explored for many years in worldwide literature. One of the most commonly cited definition and theory of innovation are those by J. Schumpeter [23]. It states that it is an entrepreneur who creates innovation, and the innovation is more than just the "invention". It is an "industrial mutation", which "incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one (…)" (p. 83). Other authors who focused on the role of innovations in enterprises were P. Drucker [3] and P. Kotler [8]. There have been also numerous contemporary studies on the influence of innovations on various areas of enterprise activity [7, 25, 26]. According to Commision Regulation (EU) No 615/2014 [2] an "innovative enterprise" is that which "can demonstrate, (…) that it will in the foreseeable future develop products, services or processes which are new or substantially improved compared to the state of the art in its industry, and which carry a risk of technological or industrial failure", or those whose "the research and development costs represent 10% of its total operating costs in at least one of the three years preceding the granting of the aid (…)" (art. 80).

The topic of innovation is closely related to the subject of inventions, intellectual property rights, patenting and introducing new products to the market, as specified in the instruction for the application within Smart Growth program. Each applicant is therefore obliged to justify the innovativeness of the results of his project, and it is one of the main criteria of the project evaluation (instruction).

In the context of assessing the fulfillment of this criterion, the concept of innovation has been taken from Oslo Manual [20], which defined four types of innovations:

1) product innovation,
2) process innovation,
3) organizational innovation,
4) marketing innovation.

The criterion is considered fulfilled only if the solution proposed in the proposal concerns product or process innovation. Product innovation is understood as a "significant change that distinguishes a product resulting from a project with products having similar underlying functionality", while process innovation as a "technological change in technology, devices, and/or software" [12].

It should be emphasized that the requirement defines that product or process

innovation is new at least in the Polish market. In practice, however, it is worth pointing out that innovation should have global, not local (national) character, as this increases the chances of a positive evaluation of the proposal. Besides, it is much easier to prove product innovation than process innovation, which requires specific justification for "significant change". On the other hand, indicating the result of the project as an organizational or marketing innovation results in failure to meet the criterion.

In addition, the result being simply product or process innovation is not enough to be successful in applying for the EU funds under the Smart Growth Program. One of the necessary conditions for each project submitted within this program to be assessd positively is to fit in at least one of the National Smart Specializations. There are 20 areas of NSS, namely [13]:

1. Medical engineering technologies, including biotechnologies.
2. Medical diagnostics and treatment of lifestyle diseases and personalized medicine.
3. Production of medicinal products.
4. Innovative technologies, processes and products of the agri-food and forestry-wood sectors.
5. High quality food.
6. Biotechnological processes nad products of specialized chemistry and environmental engineering.
7. High efficiency, low-emission and integrated manufacturing, storage, transmission and distribution of energy systems.
8. Smart and energy efficient construction.
9. Environmentally friendly transport solutions.
10. Modern technologies of sourcing, processing and use of natural resources and the production of substitutes.
11. Minimizing waste including unfit for processing and use of materials and energy waste (recycling and other recovery methods).
12. Innovative technologies of processing and recovery of water and reducing its consumption.
13. Multifunctional materials and composites with advanced properties, including nano-processes and nano-products.
14. Sensors (including biosensors) and smart sensor networks.
15. Smart networks and geo-information technologies.
16. Electronics based on conducting polymers.
17. Automation and robotization of technological processes.
18. Optoelectronic systems and materials.
19. Smart creative technologies.
20. Innovative maritime technologies pertaining to specialist vessels, maritime and offshore structures and logistics based on maritime and inland waterway transport.

By analogy, the Applicants who apply for regional funds (within Regional Operational Programs) have to fit in at least one regional specialization, which are defined for each region (voivodship) individually, taking into account their specific industrial and/or environmental conditions. For example, the Silesian region specializes in e.g. mining industry, so all the innovations must be for the benefit of this sector.

The product to be perceived innovative has to be in line with at least one of the national or regional specialization, dependent on the program under which the proposal is submitted. It is another major difference of Smart Growth program compared with the previous Innovative Economy, which did not oblige the aplicants to fit in the pre-specified areas of innovations.

4. DEFINING NOVELTY AND R&D ACTIVITIES IN THE SMART GROWTH PROJECTS – CASE STUDIES

The most popular measures of the Smart Growth Operational Program under which Polish enterprises submit their R&D projects include 1.1.1 (Industrial research and experimental development conducted by enterprises, so called “Fast Track”) and 1.2 (Sectoral R&D programmes for enterprises and concortia of enterprises). Three successful project proposals prepared by three different companies who cooperate with the author of this paper have been analysed. To keep anonymity of the enterprises the author does not show their names and any sensitive information. The projects were analysed in terms of how they define innovations and respective R&D activities. They were

submitted under the measures 1.1.1 and 1.2 of the Smart Growth between June 2015 and January 2017 by Polish enterprises (small and medium) of different profile and with various experiences in the market and in R&D activities. They are shortly characterized below.

Project 1: Innovative machine for food preservation
Submitted under 1.1.1 by the small enterprise established in 2014 as a spin-off company by young scientists with doctoral degree. They had all compatencies to carry out the R&D activities, but lack of experience in implementation and business. The product was innovative on a global scale, and the innovation fit in two National Specializations: No 4 (Innovative technologies, processes and products of the agri-food and forestry-wood sectors) and No 13 (Multifunctional materials and composites with advanced properties, including nano-processes and nano-products). The project consisted of four stages: three of them were industrial research, one experimental development.

Project 2: Innovative robotized system for removing pigment particles from ink chambers
It was also submitted under 1.1.1 by medium-sized company established in 2000. Contrary to the previous applicant, this company has long-term experience in business but less experience in R&D activities, so it employed scientists from local research institute and technical university. The result was defined as innovative on a global scale, and the innovation fit in National Smart Specializations No 17 (Automation and robotization of technological processes). The project consisted of four stages: three of them were industrial research, one experimental development.

Project 3: Innovative energy storage system
The project was submitted under sectoral measure (1.2) by medium-size enterprise established in 1998, with long-term experience at international markets. The company also carries out R&D activities, financed mostly from own resources. The proposed result was defined as innovative on a global scale, and the innovation fit in National Smart Specializations No 7 (High efficiency, low-emission and integrated manufacturing, storage, transmission and distribution of energy systems) and 9 (Environmentally friendly transport solutions). The project consisted of five stages: three of them were industrial research, two of them were experimental development.

The major difficulty in defining the R&D activities in all the above cases was to decide on the initial Technology Readiness Level (TRL) with respect to industrial research and experimental development activities. According to Commision Regulation (EU) No 651/2014 [2], "industrial research" means the "planned research or critical investigation aimed at the acquisition of new knowledge and skills for developing new products, processes and services, and for bringing about a significant improvements in existing products, processes and services. It comprises the creation of components of complex systems and may include the construction of prototypes in a laboratory environment or in an environment with simulated interfaces (…)" (art. 85). The "experimental development" has been defined by the same Regulation as "acquiring, combining, shaping and using existing scientific, technological, business and other relevant knowledge and skills with the aim of developing new or improved products, processes or services" (art. 86). The measures 1.1.1 and 1.2 require conducting at least one stage of experimental development, while industrial research is not obligatory. However, the applicants gladly implement them as they have higher intensity of financial support (see: **Table 1**).

Determining the current life-stage of the innovative technology proposed in the project is crucial for deciding whether industrial research should be carried out, or only experimental development, or maybe the product is already on the level ready to be implemented without further R&D activities. To help entrepreneurs determine the product development stage, it is suggested to use so-called Technology Readiness Level (TRL). This terms was used for the first time by NASA [22] and presented graphically as a "thermometer" (**Figure 1**). Numerous publications and guidelines exist on this subject, all of them refer to 9 levels of technology maturity, from "1" – fundamental research, to "9" – technology tested and ready to implement, and using NASA terminology – actual system "flight proven" through

successful mission operations [1, 21].

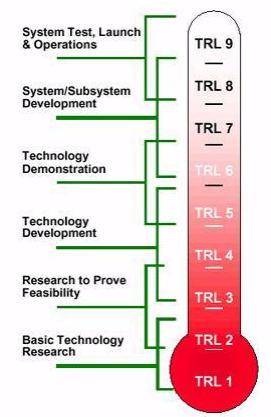

Figure 1. Model of Technology Readiness Level
Source: www.nasa.gov [11]

According to guidelines by the National Centre for Research and Development, TRL 1 corresponds to fundamental research, TRL 2-6 – industrial research, while TRL 7-9 – experimental development [13]. All the analysed applicants declared that their products are at the initial level of TRL 3, and the subsequent R&D stages were designed in a way to fulfil the next levels of technology maturity. The projects were successful because the R&D stages were described in detail. Each stage was divided into tasks (5-12), which were coherent and ended up with a well justified TRL. Milestones of each stage were also described and numerical indicators of their fulfillment were provided.

5. CONCLUSIONS

Tha aim of this paper was to present the key aspects of the Operational Program Smart Growth as the largest national program for financing research, development and innovation in Poland under the Framework 2014-2020. Three successful project applications, submitted by three Polish enterprises under the measures 1.1.1 and 1.2, have been assessed to identify what are the key factors to make successful project applications.

The key to success is properly defined innovation and R&D stages, in terms of Technology Readiness Levels (TRL) and in accordance with the relevant program documentation. The author observed that describing innovation and R&D stages takes approx. 50-70% of time in preparing the whole application. Innovation must be linked with technological challenges, which are solved through realization of R&D tasks. Thus, these tasks have to be described in a coherent way. Defining milestones of each stage is also very important, linked with the relevant, numerical indicators.

Obviously, in order to obtain co-financing, the applicant has to fulfill other criteria, too. For example, it is necessary to prove that there is a demand on the market for the results of the project and if the research is successfully completed, the implementation of its results will be possible (e.g. in own economic activity of the entrepreneur, or in the form of granting licenses or sale of the project results to implement them in the economic activity of other enterprise). The quality of R&D and management personnel is also assessed, as well as technical resources. However, the innovation and R&D activities should be used as a startpoint for the whole application.

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