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Challenges connected with monitoring of smart specializations in less developed regions of the EU

Wyzwania związane z monitoringiem inteligentnych specjalizacji w słabiej rozwiniętych regionach Unii Europejskiej

ABSTRACT

The article presents the problems and challenges in the area of monitoring of smart specializations considered as priority areas of Regional Innovation Strategies for Smart Specializations (RIS3) based on the example of the Pomeranian Region of Poland. In the article general assumptions of designing a monitoring system as well as international recommendations and examples are presented with conclusions about the problems that are faced by less developed regions with fewer resources and traditions in gathering specialized data for monitoring of priority areas. The process of designing and caring on monitoring of smart specializations in Pomeranian region is presented with the an analysis of available data sources for monitoring indicators, their weaknesses and strengths.

Moreover, the authors' proposition of a monitoring system of priority areas of smart specializations in the Pomeranian region is presented based on the logic of indicators related to the resources, symptoms and effects of smart specializations.

The proposition also embraces additional sources of data other than the most widely used data from statistical offices, that is data from the Patent office, data bases of scientific publications, data on projects connected with basic research and others.

The applied research methods include analysis of literature, source materials and documents, as well as statistical data and other data (data on R&D projects, intellectual property rights protection, scientific publications, new business entities), which can be used for the monitoring system in terms of their strengths and weaknesses from the perspective of using smart specializations in less-developed regions of the EU in monitoring, based on the example of the Pomeranian Region.

Keywords: smart specialization, innovation, Pomeranian.

STRESZCZENIE

Przedmiotem rozważań autorów są problemy i wyzwania w zakresie monitorowania inteligentnych specjalizacji traktowanych jako priorytetowe obszary regionalnych strategii innowacyjnych inteligentnych specjalizacji (RIS3) na przykładzie województwa pomorskiego. W artykule przedstawiono ogólne założenia projektowania systemu monitoringu oraz międzynarodowe rekomendacje i przykłady wraz z wnioskami na temat problemów, z którymi borykają się słabiej rozwinięte regiony, o mniejszych zasobach i tradycjach w gromadzeniu specjalistycznych danych do monitorowania priorytetowych obszarów. Przedstawiono też proces projektowania i realizacji monitoringu inteligentnych specjalizacji w województwie pomorskim wraz z analizą dostępnych źródeł danych do monitorowania wskaźników oraz ich słabych i mocnych stron.

Ponadto na podstawie analizy dostępnych wskaźników związanych z zasobami, objawami i efektami inteligentnych specjalizacji autorzy przedstawili propozycję systemu monitorowania priorytetowych obszarów inteligentnych specjalizacji w województwie pomorskim, a także dodatkowe źródła danych, inne niż dotyczchas wykorzystywane zasoby urzędów statystycznych, tj. dane z Urzędu Patentowego, bazy danych publikacji naukowych, dane o projektach związanych z badaniami podstawowymi i inne. Stosowane metody badawcze obejmują analizę literatury, materiałów i dokumentów źródłowych, a także danych statystycznych i innych źródeł (dane o projektach B+R, ochronie praw własności intelektualnej, publikacjach naukowych, nowych podmiotach gospodarczych), które można wykorzystać w systemie monitoringu. Analiza obejmuje badanie ich mocnych i słabych stron pod kątem wykorzystania w monitoringu inteligentnych specjalizacji w słabiej rozwiniętych regionach UE, na przykładzie województwa pomorskiego.

Słowa kluczowe: inteligentne specjalizacje, innowacja, pomorskie.

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INTRODUCTION

Smart specializations (SS) are economically related fields of science that have been selected by individual regions for the needs of smart specialization strategies that form the 3rd generation of regional innovation strategies in the EU (RIS3). These areas can receive regional support under the Structural Funds for research schemes. Their choice results from the necessity to prioritize and focus resources on research in areas that, in the given region, can bring the best results in terms of implementation of innovative and internationally competitive solutions, which result from the current structure and development of regions.

In the *Monitoring and Evaluation Guidelines for the 2014-2020 programming period*, the European Commission recommended that the monitoring system should be based on three types of indicators: input indicators–referring to the budget allocated to the support of a given area, product indicators – describing the "physical" product of resources generated as a result of policy intervention and result indicators – describing a specific aspect of the result, a feature that can be measured. The result refers to the positive changes that increase well being (European Commission, 2014; Monteiro, Santos, Guimarães, & Silva, 2018).

Strategies for smart specializations, as well as their monitoring systems can be strategies that adapt, i.e. they can change due to the learning process during their implementation. The monitoring system should, however, serve such learning (Kleibrink, Gianelle, & Doussineau, 2016; McCann & Ortega-Argilés, 2016).

The aim of the article is to present the issue of monitoring of priority areas of smart specialization strategies at the regional level from the perspective of international recommendations and experiences and problems that affect the less developed regions of the EU on the example of monitoring system of smart specializations of Pomerania. In addition, existing data sources for monitoring are assessed and a modification of the monitoring system for the Pomeranian Voivodeship is proposed so that it reflects the monitoring logic of international recommendations. New data sources for the monitoring system are also proposed, which are easy to obtain, taking into account the scarcity of funds earmarked for this purpose in the less developed regions of the EU.

1. LITERATURE REVIEW

The motive for undertaking the issue of smart specializations was a theoretical study, which resulted in a bibliometric analysis based on two scientific databases: Web of Science and Scopus. Based on the results obtained, a research gap was formulated, consisting of a small number of publications on the concept of measurement methodologies and monitoring of the potential of smart specializations in Poland.

In this section of the article, the following parameters were quantified: number of publications and citations (Figure 1a and 1b), document type and h-index for the *smart specializations* entry, which was searched for the category of articletitle. The results of the first two parameters are shown in Figure 1a and 1b.

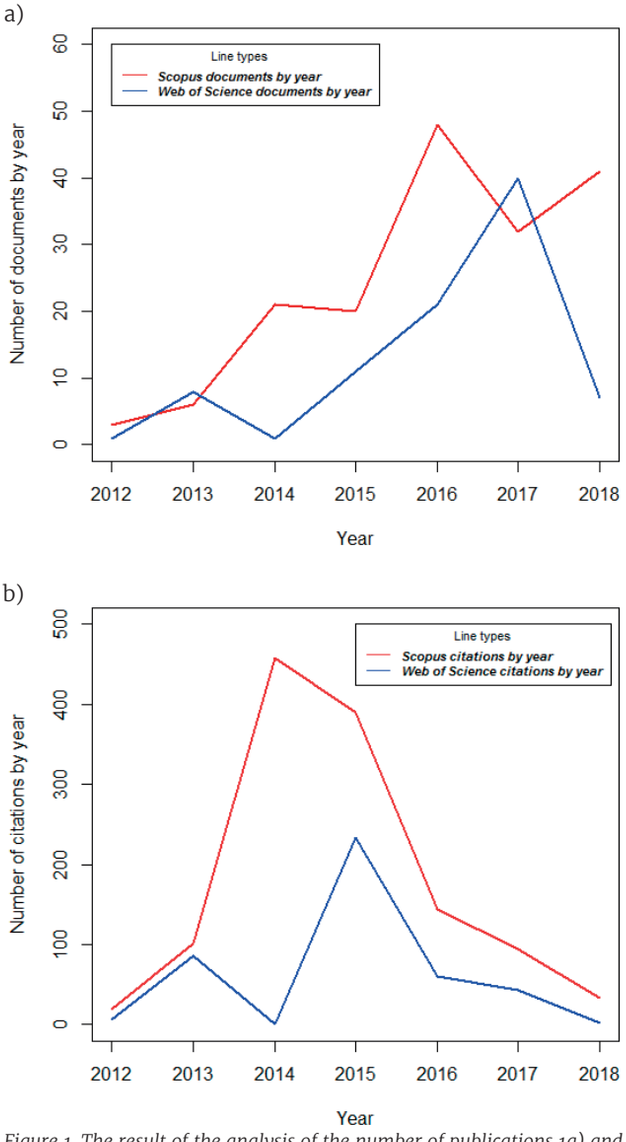

Figure 1. The result of the analysis of the number of publications 1a) and citations 1b) in the Scopus and Web of Science databases

Source: own study based on Scopus, Web of Science and the Google Trends tool using the R programming language.

As a result of this part of the analysis, the following parameters were verified in the Scopus and Web of Science databases: total publications – 169 / 172, h-index: lack of data / 12, average citations per item: 7,25 / 3,86, sum of times cited 124 / 664. In both of the databases analysed, the largest share of document types were: article, book chapter and proceedings paper/conference paper. At this stage of the study, attention was paid to the country of origin of the authors of the study. In the Web of Science database, the largest number of articles was submitted in Poland (12,21%), Italy (11,63%) and England (10,47%). On the other hand, in the Scopus da-

tabase, the largest number of documents was recorded for Italy (17,16%), the Netherlands (14,20%) and the United Kingdom (13,02%), while Poland ranked fifth (8,88%).

Based on the issue that was discussed, the next part of the analysis carried out a qualitative assessment of the studies on the problem of monitoring the smart specializations in the example of regions in Poland. In view of the earlier part of the study, a study presenting the characteristics of selected methodological approaches to identification of smart specialization at the regional level in Poland was presented (Gulc, 2015). In turn, M. Markowska, M. Kusterka-Jefmańska and B. Jefmański (2016) in their study identified the applied analytical approach, based on the use of fuzzy classification in the analysis of dynamic data on the example of 265 European regions at the NUTS 2 level, described by variables characterizing shares in employment in economic sectors. The next article included in the study presents methods and results of the identification process in the Pomeranian Voivodeship and presents the result of the evaluation analysis in the areas of smart specialization (Kamrowska-Zaluska & Soltys, 2016). The study in which an attempt was made to identify the links between smart specialization and sensitivity to crisis in regions of the European Union is also noteworthy. The study covered the NUTS-2 level regions in 2005-2011 (Bal-Domańska, 2016). The article by A. Smoliński, J. Bondaruk, M. Pichlak, L. Trząski and E. Uszok (2015) presents econometric models for panel data with appropriate estimation techniques used to assess the sensitivity of EU regions to the effects of the 2008 crisis. The study presents the original procedure development of the science-economy-technology compatibility matrix based on the example of smart specialization in the Silesian Voivodeship.

2. DESIGNING OF MONITORING SYSTEM OF SS – INTERNATIONAL PERSPECTIVE

According to the recommendations of the *Fifth report on economic, social and territorial cohesion* of the European Commission, the approach to the selection of monitoring indicators should be minimalist, conservative and realistic (European Commission, 2010). When monitoring indicators of smart specialization, one should also take into account the main features that the priority areas/technologies should be characterized by, such as: conducting R&D works, cooperation between enterprises and science, international competitiveness, occurrence of critical mass in the aspect of R&D activity in the region, based on entrepreneurial discovery, the potential of interdisciplinarity and the degree of novelty/niche specialization allowing the system to distinguish itself on an international scale (Pander, Reuzer, Stawicki, Sycz, & Wojnicka-Sycz, 2014). The development of a monitoring system is necessary to diagnose whether the regional smart specialization strategy is implemented as planned, which supports decision-making regarding possible changes or maintaining priority areas and the ways of implementing the strategy. It also allows dissemination of information on strategic achievements (European Commission, 2018a).

This section of the article presents the SS monitoring systems based on the examples of two regions: Norte in Portugal and Emilia-Romania in Italy.

As part of the proposed RIS 3 monitoring system in the Norte region in Portugal, the monitoring of individual measures, like projects, with the aim of achieving specific inputs, outputs and results indicators was considered. Next, it is checked whether strategic and cross-cutting goals are achieved through result indicators and indicators for individual priority areas. The third level of monitoring was the contextual (impact) indicators that allow monitoring the overall level of RIS3 implementation. The context indicators ensure the monitoring of key variables related to regional innovation performance in the region and allow a comparable analysis of results with other national and European regions. In this dimension, the Regional Table for the Innovation Results can be used, which is an extension of the European Innovation Table and evaluates EU regions in terms of Eurostat indicators (European Commission, 2018b). Monitoring the indicators related to the priority RIS 3 domains is of key importance in the monitoring system of strategies for smart specializations (Monteiro et al., 2018).

The Emilia-Romania region (NUTS 2, 4,48 million inhabitants) in Italy provides the second example of a developed and completed system for monitoring strategies for smart specializations. This system also includes transformation indicators, i.e. indicators specific to individual priority areas, however, these indicators are clearly linked to the priorities and thematic orientations of the strategy. In addition, it shows, especially at the level of transformation indicators, the use of various data sources, mainly collected by specialized regional institutions or associations of enterprises, as well as those based on the ongoing direct research. It should be noted that in Italy, there is an obligation to belong to affiliating institutions, such as the association of a given trade, and thus it is easier for these institutions to collect data. The monitoring system of areas of specialization in Emilia-Romania (E-R) is therefore based on a network of institutions, often financed from regional resources. It also reflects long-standing traditions in the monitoring of variables and topics defined in the RIS3 strategy in the region, as the values of monitoring indicators in many cases 4 are recorded as late as 2010. In less developed regions of the European Union, there are no such networks of institutions conducting specialized monitoring, which reflects the institutional weakness of these EU regions. The creation of such institutions and their research would require significant funds to be allocated to them. Transformation indicators in Emilia-Romania are embedded in the recommended logic of the RIS3 monitoring, i.e. inputs-products-outputs. The smart specialization strategy in Emilia-Romania (E-R) defines 5 main production areas on which regional innova-

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tion policies should be concentrated, 3 of which are: agricultural and food, mechatronics and automotive engineering and construction, the other 2 – health and well-being, culture and creativity – are areas with great potential for expansion and changes also for other components of the production system (Regione Emilia-Romagna, 2018). Monitoring in E-R applies to indicators referring to a specific area of specialization and to a specific thematic orientation indicated while defining the strategy. The system of indicators for S3 monitoring in Emilia-Romania includes product, specialization, transformation and result indicators:

- product indicators –their goal is to measure the level of implementation of regional policies and related activities,
- specialization indicators–their goal is to assess the level of 5 regional production systems in relations to 19 thematic orientations identified by S3, in terms of patent applications, research grants, start-ups and innovative SMEs,
- transformation indicators – their goal is to measure the direction and intensity of expected changes in 5 production systems (areas of specialization) in relation to the technological objectives of the strategy. Transformation indicators for 2 areas of specialization are presented in Table 1.

Table 1. Examples of transformation indicators in Emilia-Romania

Specialization area	Innovation engine	Transformation indicator
Construction Data: Regional Development Agency of E-R, Smart City Index Report, GreenEr Observatory, Lepida – institution for ICT network development	Sustainable development	Construction of new buildings. Construction of buildings with low energy consumption. Environmental certificates of the construction process. Environmental product declarations.
	Information society	Share of ultrafast Internet connections. Smart city index.
Health and well-being Data: Regional Health Service, Ministry of Health, Assobiomedica – Health Service Association, AIFA – Italian Pharmaceutical Agency, Italian Statistical Office	Companies operating in the medical equipment industry. Start-ups. Electronic distribution of health data (ESF). Laboratories certified by BPL. Innovative medicines undergoing clinical trials. Local units operating in the supply chain. Employees in local supply chain units.	

Source: http://www.regione.emilia-romagna.it/s3-monitoraggio/transizione.htm

- result indicators – their goal is to measure the effectiveness of the strategy in relation to the objectives set, i.e. to achieve results consistent with the desired objectives of the changes. Data about them come from the Italian Statistical Office (e.g. R&D share in GDP).

During the second meeting of the RIS3 monitoring working group under the auspice of the European Commission in May 2017, the participants agreed that: the approach of historical data analysis should be adopted –taking into account changes in time of individual indicators, which should be presented against the background of, e.g., national average or in relation to the model EU regions. In the case of the lack of appropriate statistical data, it may be necessary to conduct surveys to collect data for the monitoring system. Two types of questionnaires were discussed. The first one – ex ante and/or ex post in relation to the support beneficiaries. The second one – periodic examination (for example, every 2 years) with a permanent set of companies in the region, selected in a targeted manner (size, sector, geographical location, etc.). This type of "business barometer" can be very useful for evaluating products and consequences resulting from the implementation of RIS3.

3. MONITORING SYSTEM OF SS IN POMERANIA

In the Pomeranian Voivodeship in Poland (2,3 million inhabitants), the following smart specializations (PSS) were indicated:

- **PSS 1** – Offshore and port-logistics technologies;
- **PSS 2** – Interactive technologies in an information saturated environment;
- **PSS 3** – Eco-efficient technologies in the production, transmission, distribution and consumption of energy and fuels, as well as in construction;
- **PSS4** – Medical technologies in the field of civilization diseases and the aging period.

Smart specializations in the Pomeranian Voivodeship were selected based on a competition in which the partnerships of enterprises and scientific units participated, thus in a bottom-up manner. The specificity of the region is the selection of smart specialization through the prism of technology, not industries. The approach to monitoring proposed in the Pomeranian Voivodeship includes general indicators – the same for individual PSS, based mainly on the CSO data, grouped into indicators reflecting the dynamics of PSS, innovation and competitiveness indicators and indicators of the impact on the economy of Pomerania, as well as specific indicators depicting the level of development of individual PSS and differing for individual priority areas. The set of a dozen or so indicators specific to each of the smart specializations of Pomerania (PSS) 4illustrating their development was proposed by Delloite. The indicators proposed by Delloite are based mainly on data from the Central Statistical Office (CSO): from the Local Data Bank (LDB) or the Statistical Yearbook of the Maritime Economy (SYME). Moreover, many indicators have been proposed for obtaining for a fee or paid on one's own, e.g. from direct research. Delloite proposed 15 indicators for PSS 1, 12 for PSS 2, 13 for PSS 3 and 18

specific indicators for PSS 4. According to international recommendations, the specific indicators proposed by Delloite are too numerous (Delloite, 2015). Many indicators proposed by Delloite are based on data collected by the CSO according to the first NACE number declared by companies, and as demonstrated by the expertise of T. Plenikowska-Ślusarz and T. Jurkiewicz (2017) often the NACE numbers that should be specific for a given PSS do not correspond to the actual NACE indicated by the enterprises, which formed the agreement. Data of the Central Statistical Office also often, apart from data based on economic entities register REGON or referring to people, i.e. collected from various registers, are characterized by a significant delay – they are published at least 1,5 years from the moment of the event. However, the indicators proposed by Delloite for individual PSS are so numerous that they enable the selection of 3-4 indicators specific to individual PSS subfields that can be used for PSS and give the opportunity to assess the level of PSS development.

In the expert opinion by E. Wojnicka-Sycz, P. Sliż and P. Sycz (2018) for the indicators, for which data are available, they were presented together with the assessment of their actual convergence with the analysed smart specializations. Among these indicators, indicators that can be used for PSS monitoring were selected using publicly available CSO data from the CSO Local Data Study and the Statistical Yearbook of Maritime Economy and databases of international projects, i.e. the European Union Framework Program Horizon 2020 (H2020) and grants from the European Economic Area (EEA). Despite the problems related to the use of statistical data according to the NACE (Nomenclature statistique des Activités économiques dans la Communauté Européenne), it seems that one should not completely omit the data based on this classification, because CSO data are still the widest available data illustrating socio-economic phenomena in Poland. In addition, the analysis using NACE allows the assessment of the development of sub-disciplines that make up individual PSS.

New sources of data have also been proposed:

- Assessment of the dynamics of individual PSS through the prism of the analysis of new entities registered in REGON in 2014-2018 at the level of PKD classes assigned to individual PSS in the study of the Marshal's Office (2017). Data obtained directly from the Statistical Office from the department dealing with REGON (not available in CSO local data study nor statistical yearbooks).
- Use of project data from the National Science Centre (NCN) from the OPUS competition, financing basic research, which is the largest NCN program.
- Use of databases of the Patent Office of the Republic of Poland on inventions (patents), utility and industrial designs.
- Use of international publication databases, i.e. Web of Science and Scopus.

Basic research in Poland is financed by the National Science Centre. Most funds are distributed as part of the OPUS competition[1]. The monitoring indicators based on the number and value of projects financed from the OPUS competition in a given year related to individual PSS and their share in the total number of research projects financed by NCN as part of the OPUS competition in a given year will reflect resources for individual PSS in the form of finances resources, and indirectly also human ones for basic research, which may discover new scientific laws, which in the future may become the basis for the development of practical inventions. The strength of this indicator is easy access to project data from the NCN database, which is updated after each competition (NCN, 2018). Moreover, this database analyses projects in the system of provinces. Its weakness is its inability to indicate individual years – data are obtained in the system of competitions, however, data from two competitions from a given year can be assigned to a given year.

Another proposed new monitoring indicator, reflecting the signs of PSS activity, is the number of new entities registered in the REGON register in the voivodeship in the years analysed in NACE classes related to PSS. Sub-classes related to PSS were indicated based on the study of the Marshal's Office from 2017 that constituted the annex to the PSS monitoring Report from 2017. The strength of this indicator is the detail in terms of activities, as the data can be obtained from the CSO department dealing with REGON at the level of NACE classes. The analysis of data on new entities over the next several years may also indicate new potential fields of activity if entities in NACE classes are not introduced or where there are many more entities than the average in previous years, which may help monitor entrepreneurial discovery. Data on new entities do not have the general defect of the number of entities registered in REGON, which is the fact that many entities that do not currently operate are listed (e.g. they have suspended operations or have been liquidated, and have not yet been removed from the REGON register), which means that actual number of active entities is about 2 times lower than the number of entities registered in the REGON. The weakness of this indicator, similarly to the other CSO data, is that it is based on the first NACE number provided by companies and may not reflect their actual activity, but it should be presumed that in the year when the company's operations begin, they operate to the greatest extent in the NACE area indicated as the main one, or at least they have such an intention.

Another proposed indicator is the index based on the data of the Patent Office (PO) of the Republic of Poland (RP). It is proposed to use the PO of the RP databases in terms of rights obtained for patents, utility and industrial designs.

[1] For example, from the NCN competitions resolved in 2017 under the OPUS 12 and 13 competitions, PLN 693 million was awarded, while in all competitions, PLN 1155 million. Thus, the OPUS competitions have distributed about 60% of funds from the NCN (2018).

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The strength of this indicator is the easy and free access to data from the PO of the RP (2018). Moreover, these databases are up-to-date in terms of rights obtained, but due to the long time it takes to obtain many protection rights, especially patents, it is better to conduct the analysis once every few years, as inventions reported in a given year in the monitoring period will often get protection only after 1-3 years. The weakness is the need to search for data by the location of the reporting institution/persons and limitations as to the possibility of simultaneous search according to numerous locations.

Another indicator which has been proposed is the number of publications by keywords and scientific categories/ fields of science related to PSS in international databases: Scopus and Web of Science. These are databases of reviewed scientific publications. Inclusion of a journal or other publication in these databases proves their reputation. In addition, such incorporation ensures international recognition of a given publication/article and is indicative of the level of 3research conducted which has aroused international interest. Therefore, this indicator indicates research carried out in the area of PSS, mainly basic, but also application ones, which does not have a security classification and whose applications could be published. Furthermore, it shows to what extent these studies were innovative in order to generate international interest, which increases the probability of developing solutions within PSS that will be internationally competitive. The strength of this indicator is the easy and non-deleted access to publication databases. Its weakness is the necessity to buy access to these databases to conduct analysis (scientific units buy it). In addition, the analysis conducted showed that the Scopus database will be a more suitable database for searching publications due to a better search engine for articles by keywords.

Indicators based on the PO of the RP and scientific publications, as well as data on NCN projects, in particular will enable monitoring, through the prism of individual priority technologies, which is the specificity of defining the SS in the Pomeranian Voivodeship. Data from the CSO give the opportunity to analyse individual economic areas of PSS in terms of NACE sections or NACE classes, or other variables specific for individual sub-fields of activities related to the technologies of individual PSS.

4. MODIFICATION OF THE MONITORING SYSTEM

Indicators for individual SS should create a system based on intervention logic, i.e. including (1) resources for SS (inputs), (2) evidence of SS activity (products) and (3) effects of SS activities (results). Such monitoring logic will also reflect the recommendations of the European Commission regarding the monitoring and possession of the input, product and result indicators in the monitoring systems.

Input indicators will be matched by monitoring indicators from a resource block that reflects human, material or scientific resources, and therefore purposefully conducted work in the field of basic research by university graduates.

> The product indicators will be matched by indicators from the symptom block, i.e. manifestations of SS activity in the form of R&D projects carried out aimed at practical implementations, i.e. from the field of applied research and developmental works. In addition, the evidence of the SS activities will also include new entities arising in the business areas related to them, which will show the attractiveness of these areas and new ideas for running enterprises in these areas. Result indicators will be primarily matched with indicators related to the effects of SS activities, i.e. intellectual property rights obtained, as well as scientific publications in international databases, and other ones specific to individual SS.

The monitoring system should also provide the ability to monitor individual areas of activity and technological areas of the PSS indicated earlier.

Table 2 presents a recommended set of basic indicators reflecting the logic: resources, symptoms and effects for monitoring individual PSS together with determining whether it applies to all PSS or individual sub-types of activity/technology as part of PSS together with an indication of data sources for these indicators.

Monitoring indicators have been proposed based on these criteria:

- Easy data availability at a low cost,
- Where possible, no link to NACE codes, which often do not reflect the actual operations of the companies,
- In the case of interactive technologies, it was decided to omit indicators based on data on NACE divisions, but refer to the human potential crucial in the case of this specialization (working and remunerations),
- In the case of medical technologies, indicators related to the research activity carried out in the PSS, as well as its effects and showing the level of development of medical services, especially for the elderly, were indicated.

In addition, the same indicators were proposed for all specializations, but enabling analysis for individual technological areas and based on new data sources: protection of intellectual property rights, scientific publications and projects for basic research. To reflect the individual fields of activity related to PSS at the level of NACE classes for all PSS, an indicator of newly registered entities was recommended, and to reflect the level of internationalization of specializations, participation in the international R&D and application projects. It should be noted that if regional authorities establish cooperation with an institution collecting data on exports, in the case of the Polish Chamber of Fiscal Administration, to illustrate the international competitiveness of smart specializations, it would be worth expanding the monitoring indicators referring to exports associated with individual smart specializations according to the CN (Combined Nomenclature)product classification sections.

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Table 2. A set of indicators of the PSS monitoring

Indicator (Data source)	Technologies			
	offshore and port-logistic	interactive	eco-effective	medical
Resources				
Share of graduates of faculties and specializations related to PSS 1 in the total number of graduates (RSGM, BDLCSO)	Total of individual PSS			.
Maritime transport fleet by ship age (RSGM)	Port-logistic	.	.	.
Projects in the field of basic research related to PSS (NCN)	Total of individual PSS			
Internal inputs for R&D according to science and technology – total inputs in the field of medical and health sciences PLN (BDL CSO)	.	.	.	Total PSS 4
Internal inputs on activities in the field of biotechnology in enterprises (BDLCSO)	.	.	.	Pharmacy and cosmetics
Evidence				
Share of Polish entities in international projects co-financed by the EU (Cordis, EEA grants)	Total of individual PSS			
New entities associated with PSS arising in individual years (REGON)	Total PSS and Individual areas of PSS			
Working in the ICT industry (CSO)	.	Total and divisions of NACE	.	.
Production of electricity from renewable sources (CSO)	.	.	Energetics	.
Enterprises operating in the field of biotechnology (CSO)	.	.	.	Pharmacy and cosmetics
Number of beds in hospices, care and treatment centres and nursing the care facilities per 100,000 population (BDLCSO)	.	.	.	Tech. of the aging period
Effects				
International turnover in seaports in tonnes (CSO)	Port- logistic	.		
Ship production [thousand CGT] (CSO	production	.		
Average monthly salary/wages and remuneration per employee (CSO)	.	Total and divisions of NACE		
Sales of thermal Energy converted into the volume of residential buildings	.	.	Energy efficiency in construction	
Total energy consumption per 1 million PLN GDP	.	.	Total PSS 3	
Share of electricity produced from renewable sources in total electricity production	.	.		
The energy balance of the voivodeship	.	.		
Number of patients treated stationary in the hospitals and spa sanatoriums in the Pomeranian Voivodeship (CSO)	.	.		Technologies of the aging period
People who were provided with health services at the age of 65 and more (CSO)	.	.		
Average life expectancy at the time of birth of women and men (CSO)	.	.		TotalPSS 4
Deaths from cancer and cardiovascular diseases per 10,000 inhabitants (CSO)	.	.		Civilization diseases
Protection of intellectual property rights related to PSS (PO of the RP)	Total PSS and technological areas of PSS			
Scientific publications in the international database according to keywords (Scopus)				

Source: own study.

Moreover, for PSS 1, PSS 2 and PSS 3, an indicator of the share of graduates associated with PSS was recommended in the total number of university graduates in the region. This indicator, reflecting the resources for specializations, was not selected in the case of medical technologies, because the education policy in this area is too regulated at the national level, and because of the cost of studies it is impossible to adapt it easily to market requirements.

5. CONCLUSIONS AND DISCUSSION

The system of monitoring indicators regarding individual priority areas of PSS should, in the absence of additional resources in less developed regions of the EU, be based on the generally available data of statistical offices, databases on international projects and basic research projects (in the case of Poland, NCN), as well as data on protection of intellectual property rights, also available in relevant online data-

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bases, and using data on scientific publications, in particular the Scopus database. Moreover, it is necessary to use databases on projects implemented with the support of structural funds, which are analysed in the Pomeranian Voivodeship as part of the general indicators for all PSS. These indicators will reflect both R&D and innovation, as well as international competitiveness or entrepreneurial discovery in the regions in the form of new entrepreneurship. Regional authorities should try to establish cooperation with national institutions (e.g. those collecting data on exports), and to persuade other regional institutions (like loan funds) to collect data on a cross-section of smart specializations.

However, less developed regions should lobby the European Commission for additional funds for the monitoring of smart specializations and, more broadly, for regional monitoring, because their institutional weakness resulting from a lack of tradition related to a lack of resources for collecting specialized economic data is visible. These funds should be used, among others, to create specialized regional observatories. If such funds are obtained, it should be recognized in industry institutions, e.g. partnerships for SS, whose data would best illustrate areas/technologies related to SS and from where they can be obtained periodically. Moreover, it would be desirable to extend the monitoring with data collected in direct research. For example, the innovation of specialization is reflected in part by the suggested indicator based on the PO of the RP data, but some industries, especially ICT, do notintroduce many patents, hence it is worth expanding the innovation analysis by direct research of PSS entities and more broadly based on an Internet investigation of the websites of the SS entities and data about introducing new products/services by entities related to SS, as well as their cooperation for this purpose with universities teaching international relations. Furthermore, the databases of SS entities that could be created on the basis of an investigation would expand the scope of entities that could be covered by direct research carried out in the 2-3 year cycle on SS innovation and development, as well as other issues that are important for the analysis of the SS development and support (e.g. needs in the area of human resources development).

Also an analysis of development of entrepreneurship in the region and the entrepreneurial discovery would be desirable in the context of SS monitoring, by allowing new consortia of entities to report, which would prove that the area in which they operate is future-oriented, innovative and competitive in international terms, and thus would create an opportunity to generate spill effects on the region's economy while it needs support to achieve the critical mass for development.

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