Krzysztof MIESZKOWSKI*
European Commission, Joint Research Centre – B.3,
Smart Specialisation Platform, Seville
krzysztof.mieszkowski@ec.europa.eu

THE METHODS AND RATIONALE FOR SELECTING ADVANCED MANUFACTURING TECHNOLOGIES AS A SMART SPECIALISATION PRIORITY IN LESS-INNOVATIVE COUNTRIES: THE CASE OF POLAND

Key words:

Advance manufacturing technologies, smart specialisation, priorities setting, foresight, policy diagnosis, entrepreneurial process of discovery.

Abstract

The paper discusses the methods and rationale for selecting advanced manufacturing technologies as a smart specialisation priority in Poland at a national level. The studies rely on the desk research of relevant national strategic documents. This article might contribute to a discussion if there is a point in domestic AMTs technologies creation and development or it should be just an agreed approach considering these technologies adoption. The chapter underlines the importance of KETs for the EU and provides the related policy context. The author investigates the smart specialisation process that was

* The views expressed are purely those of the author and may not in any circumstances be regarded as stating an official position of the European Commission.

imposed by EU to define development domains of Members States at national or regional level with focus on diagnosis (with some attention on foresight) and entrepreneurial discovery process. In the author's opinion, the outcome of the national S3 process maintains the country aspiration regarding AMTs creation and development for its future economic development.

Introduction

The Advanced Manufacturing Technology (AMTs) was identified by European Commission (EC) as the one of the Key Enabling Technologies (KETs). In 2009, this group of technologies was put on the political agenda considered as a key enabler for further EU growth for both service and product development [1]. The idea of KETs can be included in the concept of *general purpose technologies* [2 p. 3]. KETs became a part of the Europe 2020 strategy and are important for Innovation Union and Digital Agenda initiatives [3]. The EU industrial policy agenda also refers to KETs [4], [5]. In 2012, the EC communicated the strategy that aimed to enhance the deployment of KETs [6]. The EC established the KETs Observatory in order to develop methodology to provide information on the KETs performance of the EU countries and their global competitors [7].

AMTs can be defined in various ways [8 pp. 6–11], [9 pp. 5–6], but for the purpose of this study, their definition follows the one provided by the KETs Observatory: AMTs *encompass the use of innovative technology to improve products or processes that drive innovation. It covers two types of technologies: (a) process technology that is used to produce any of the other five KETs, and (b) process technology that is based on robotics, automation technology or computer-integrated manufacturing* [10 p. 17]. The less-innovative countries are assumed according to Innovation Union Scoreboard 2015, and this means that the countries with the score below the average Summary Innovation Index calculated for all EU countries [11].

1. KETs in the statistics

The first KETs Observatory report confirms the dominate position of Germany, France, Italy, Netherlands, and UK in KETs across the EU countries. The report analysed their position according to technology creation, technology production, technology trade, and technology turnover [10 pp. 77–79]. Only when regarding the dynamic indicators did the less-innovative countries perform high dynamics for all these categories [12], but here it must be underlined that their base values were pretty low.

The Polish low performance regarding AMTs technology creation, production, and export is reflected in the AMTs trade balance data. The trade data confirms the absorptive character of Polish economy regarding this kind of technologies [13]. The paper tries to challenge this status quo for AMTs by taking into account that Poland considers its own AMTs creation and development in its smart specialisation strategic framework. The author will explore the methods used and rationale for these choices later on.

A bit more optimistic picture of Poland, but still rather based on absorption of AMTs than their creation and production, comes out while the KETs Observatory follows the "technology diffusion" approach, which means the manufacturing of KETs-based products. The production of AMTs dependent products in Poland is relatively high, which means that the Polish industry produced products that are considered AMTs intensive, but work can still be done by the labour force [14]. In 2013, the density of robots per 10k employed in Poland (19) is much lower than in Hungary (47), the Czech Republic (72), Slovakia (89) and Europe (82) [15].

The Executive Summary of World Robotics 2015 Industrial Robots report claim that, in 2014, the sales of robots in Poland increased, but the period of time in this source is not mentioned [16 p. 3]. The GUS data covering AMTs for 2006–2014 confirms a slight growing trend of units of means of automating production processes in industrial enterprises employing over 49 people [17 p. 128], [18 p. 135]. Unfortunately, no clear growing tendency for enterprises employing up to 49 is visible for the analysed data of 2010–2014.

2. The matter of these studies

According to literature, the poorer countries try to catch up with the better-developed ones by transferring technical knowledge from them and trying to concentrate on the investment in human, physical, and institutional capital [19 p. 43]. The Polish current way of economic development seems to confirm that [20]. However, is the ambition of such countries to develop their own technologies being neglected? Should they consider the development of AMTs? If yes, what are the conditions for effective development of AMTs in these countries? Alternatively, should they just consider AMTs absorption? The Asian well-known examples of South Korea and recently China confirm that the progress is possible [13]. The idea of these studies is to find out what kind of arguments can be used to justify the decision to develop or just adopt AMTs as part of S3 implementation.

The idea of convergence is a core of Cohesion Policy carried out at the EU level [21]. Now, this policy considers R&D+I as a key driver for economic development including the lagging ones. The current financial perspective 2014–2020 imposed on the Member States the smart specialisation approach. European Structural and Investment Funds (ESIF) for research and innovation should be spent aligning to smart specialisation strategies (S3). This means setting-up *priorities to build competitive advantage* (not comparative one) *by developing and matching research and innovation own strengths to business* *needs in order to address emerging opportunities and market developments in a coherent manner, while avoiding duplication and fragmentation of efforts* [22]. *The identification of niches or specific domains as competitive advantage* is claimed to be the biggest difference in this current EU policy [23 p. 29].

In reality, the S3 priorities selection process has been rather a tricky task. The regional studies show that many economically weaker regions might have been selected priorities that are inadequate to their evidence-based techno-economic potentials [24]. As a consequence, the strategic priorities might play a recommendation role [25]. Furthermore, a lack of administrative capacities to deal with the S3 process and implementation [26] might result in poor analytical and *entrepreneurial discovery process* (EDP) outcome. Finally, the studies must cope with the fact that, while most regions in a country have a potential for endogenous structural change, only a few regions can set up new technological development route and have national and international impact [27 p. 292].

To facilitate the S3 process in the EU Member States, EC established the Smart Specialisation Platform (S3P) and provided several guidelines. The main one is the RIS3 Guide [23], which became the reference for any work related to S3 developments or the adjustments of innovation strategies to ex-ante conditionality requirements. The guide provided the policy makers with six steps to be followed in order to develop the strategy in line with the concept. For the purpose of this paper, the author will mainly focus on the first step, which is called *Diagnosis,* and on EDP, which must be implemented at each of the six steps.

3. The importance of diagnosis in the S3 process

Following the RIS3 Guide, the first step of the S3 strategic process should provide information about the regional context and potentials for innovation with a focus on regional assets and on the outward, beyond region/country, dimension. Particular attention should be paid towards *entrepreneurial dynamics* being prospects for EDP. The diagnosis is expected to look for the dynamics that are initiated, continued and executed by *entrepreneurial entities* which includes more than just enterprises but also other entities which possess *entrepreneurial knowledge* [23 pp. 18–20].

The mentioned guide provides some suggestions regarding what should be considered, e.g. *differentiation,* which means a focus on unique local knowledge, or what kind of tools can be used for the purpose of diagnosis e.g. *gap analysis,* which helps to recognise what is missing or not working correctly. Regarding the exact analytical tools, the guide refers to previous guides and experience of previous RIS exercises. The policy makers can consider the set of the following methods: *analysis of scientific and technological specialisations, analysis of regional economic specialisations, cluster in-depth case studies, peer reviews* and as well *foresight* [23 pp. 28–34].

The diagnostic methods are also important for the fourth step of the S3 process, which refers to the *identification of priorities.* A global value chain studies helps to illustrate a position of regions/countries with defined priorities in the global environment. Furthermore, this step is to verify the selection made following criteria like *the existence of key assets and capabilities, diversification potential of domains, critical mass, and their market potentials* [23 p. 51].

The overview of methods used by the Polish regions in the S3 exercises has been done by Aleksanda Gulc [28]. According to her studies, the most popular ones were desk research, statistical analysis, and SWOT analysis. The last one is mentioned in ex-ante conditionality definition [22]. To the group of less used belong individual in-depth interviews, focus group interviews, expert panels and scenario analysis. The technological foresight and Porter's analysis seems not to have been frequently used as well..

4. Foresight

Foresight is still considered in the literature as the useful toolkit for policy purposes [29], and it was used as part of S3 exercises in less-innovative countries like Romania [30], Lithuanian [31], and Poland (a national level) [32]. The usefulness of the foresight for S3 exercises comes from *its focus on action*, *openness to alternative futures*, *participatory aspects*, and a *multidisciplinary approach*. The S3 exercise should be characterised like an active process which considers a broad range of possible scenarios and a varied and broad pool of stakeholders with varied backgrounds [23 p. 32].

Although there are many positives of foresight, the utility of Polish foresights for the purpose of S3 exercise at national and regional levels was questioned [33]. The main doubts were arose about the dominance of stakeholders representing research institutions as project partners, weak governance structures, and mechanisms for priority settings (particularly their elimination), the quality of defining priorities and their granularity, and the lack of policy-mixes to support R&D-driven innovation in the selected areas. A bit more positive picture regarding stakeholders' involvement comes from the perspective of expert participation, but still in the majority of cases the research representatives dominated [34 p. 41]. The same negative reflection on the use of foresight approach was expressed by Dominique Foray. He claimed that technology foresight exercises quite often defined the similar priorities across regions or countries missing the local context and its capabilities [35 p. 5].

In Poland, the pool of foresight projects is large with over 40 projects dealing with sectors or addressing regional and national dimensions of development [34 pp. 17–20]. Among them the author indentified those which deal with themes relevant to AMTs in different ways [36], [37], [38], [39], [40], [41], but only in few cases did the evaluation studies seem to confirm that the foresight exercise might have been useful to contributing to the S3 exercise by their differentiation and balanced participation of different stakeholders in at least expert groups [34 p. 41].

5. AMTs identification during S3 processes at the national level

The definition of AMTs coming out of S3 processes can be a mix of sub-sectors, technology areas (robotics, mechatronics, sensors), or application areas which cross each other [42 p. 3]. This approach follows the expectation of smart specialisation priorities, which should consider the vertical logic *favouring some technologies, fields,* or *population of firms* [43 p. 1].

In Poland at the national level, the most relevant S3 priority addressing AMTs seems to be *Automation and robotics of technological processes* located under a thematic group named *Innovative technologies and industrial process.* The current definition of AMTs national S3 specialisation follows rather the technological typology of AMTs components without addressing any areas of their possible implementations. The other national S3 areas might address AMTs creation and development for their purpose, but further author's elaboration in this paper does not tackle them.

The general information on the national S3 process is available on www.smart.gov.pl. This webpage provides rather limited information about the selection and definition of national smart specialisation priorities. We can read there that S3 priorities were developed with the use of a wide range of analytical methods like the cross-analysis of InSight2030 Foresight (InSight2030) and National Research Programme (NPR), quantitative and qualitative analyses, and the involvement of stakeholders gathering enterprises, business supporting institutions, and research institutions [44]. More details, particularly regarding the beginning of the S3 process and the first proposal for S3 priorities, can be found in *Krajowa Inteligentna Specjalizacja* (KIS), which was adopted by the Polish government [32].

From the analytical perspective, the AMTs as smart specialisation priority took its origin from the cross-analysis of National Research Programme (NPR) and InSight2030, which is claimed to be the first step of the S3 process at a national level. The combination and overlap between two areas of NPR *(a) advanced information, communication and mechatronics technologies* and *(b) modern material technologies*, and Research Panel No. 3 of InSight2030 (PB3) *(a') advanced manufacturing systems and materials* resulted in the following definition of two AMTs related cross-sector areas: *(a) mechatronics for robots and machineries* and *(b) automation of monitoring, control and diagnostic systems* [32 p. 20]. The sets of consultation with regional authorities, research institutions, sector chambers, and business supporting institutions, clusters and business organization caused the reduction in the number of possible specialisations, but it did not affect these two areas thus both were considered in further steps [32 p. 21].

The verification of the first step settings was facilitated by qualitative and quantitative analyses. The final result of qualitative studies followed sectors according to 2-dig NACE codes and refers to the limited set of indicators regarding the following: export, gross value added of production, R&D+I expenditures, industrial enterprise which are innovative active, significant share of revenues from new products or improved products, willingness to cooperation on innovation development, patent activity at national (UP RP), and international level (EPO) [32 pp. 22–25].

In the author's opinion, the 2-dig level cannot be considered as a good proxy for AMTs in terms of their creation and production. The KETs Observatory method includes the production of AMTs according to NACE classification is in *(a) Manufacture of computer, electronic and optical products*, *(b) Manufacture of electrical equipment* and *(c) Manufacture of machinery and equipment n.e.c.,* but the definition of KETs is done at 4-dig codes level, which excludes many not directly linked to AMTs economic activities.

The qualitative analysis also followed the 2-dig level of NACE codes and addressed *the activity of enterprises in participation in projects co-funded with public funds*, *networks cooperation* and *regional smart specialisation* [32 p. 27]. In these analytical sets, the level of NACE codes did not allow identifying AMTs domains precisely [32 p. 28]. The scope of this analysis might be also questioned. On the one hand, it refers to the overview of success stories at project application level, which may illustrate innovative activity by sectors, but on the other hand, it does not include assessment of the final results of these projects.

The cross-analysis between 22 pre-selected cross-sector areas and previously ranked industrial sectors aimed at showing the links between them. This analysis helps to illustrate the importance of two AMTs related cross-sectors for each 2-digs NACE industrial sectors. Finally, they were ranked at 4^{th} and 8^{th} position [32 pp. 29–31].

In the final 5^{th} step of KIS, the Ministry applied four methods to define the final S3 priorities: (a) workshops in order to prepare SWOT analyses for each smart specialisation area with stakeholder involvement, (b) more general consultations with participants of these workshops, (c) next cross-analysis of previous cross-analysis results with output of the mentioned meetings, (d) again meetings with enterprises, consultation with socio-economic partners and individual meetings witch stakeholders, and (e) SWOT preparation. As the outcome of this part, 18 national smart specialisations grouped in 5 thematic areas where defined. The two AMTs cross-sector areas were merged into the one already mentioned at the beginning of this chapter – *automation and robotics of technological processes*.

The S3 process is a continuous one. The further work allowing further development of AMTs has been carried out by the working group. In June 2015, the focus group included 30 people. The author's analysis of the members of this group provides the following brief information about their structure. One person was representing both business and research institution. There were 18 representatives of business, 12 of research institutions and 1 of centre of excellence which is rather R&D oriented. The look at the profiles of people in the context of their affiliations confirms their variety of possible directions of AMTs development and application. The group covered technical matters like automation, mechanics, mechatronics, electronics, and sustainable technologies. Regarding sectors, the participants represented aviation and aerospace, transport, logistics, mining of row materials (cupper, coal) and their further processing, lightening, automotive, steel industry, metal products, energy, or particular products like industrial adhesive and tapes, engines, and door locks. The characteristic of stakeholders probably ensure that the scope of AMTs has been considered in the varied sense. The defined granularity of this specialisation confirms the wide range of AMTs related aspects considered.

6. Conclusions

The future prospect for incremental growth of AMTs creation and development in Poland is still unclear, but at least the field of AMTs were the subject of foresight and analytical exercises, and finally incorporated into priorities of the national S3. The positive dynamics of KETs Observatory indicators, the 5th position of Poland in AMTs' enabled employment with 80k employees, which placed Poland closely behind the UK in the EU [45 pp. 13, 28], a continuously slight increase of its share in total AMTs demand over the last five years [45 p. 16], and the mentioned GUS data concerning the number of means of automating production processes in industrial enterprises and enterprises implanting them let keep the positive expectation for the future.

Now the AMTs are a subject of the ESIF implementation through operational programmes. The important measures for their development, like the technology demonstrator or pilot lines, have already been launched. The focus on R&D-driven innovation in the areas of smart specialisation can ensure that the aspects of creation and implementation have to be taken into account by applicants in their project proposals.

The areas of Polish specialisation related to AMTs will be a matter of the author's further research in the context of S3 framework. The EU policy on KETs also influenced the Polish policy makers at a regional level who commissioned studies on that [46]. The further studies can also address this local dimension of AMTs in regional smart specialisation processes, e.g., in some declaration for Małopolska, AMTs are not a key priority but they are rather considered as enabling technologies driving key regional sectors [42 p. 54]. The final regional S3 includes electrical engineering and machinery industry. Thus, the different aspects of AMTs can be developed within these industries. The further studies should determine if the AMTs are either enabler for regional smart specialisation development or a smart specialisation priority as such.

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Metody i przesłanki stojące za wyborem zaawansowanych technologii produkcyjnych jako jednej z inteligentnych specjalizacji w mało innowacyjnym kraju. Studium przypadku – Polska

Słowa kluczowe

Zaawansowane technologie produkcyjne, inteligentna specjalizacja, priorytety, forsesight, diagnoza, proces przedsiębiorczych odkryć.

Streszczenie

Artykuł analizuje metody i przesłanki stojące za wyborem zaawansowanych technologii produkcyjnych jako inteligentnej specjalizacji w Polsce na poziomie krajowym. Analiza opiera się na przeglądzie strategicznych dokumentów polityki. Studia te mogą kontrybuować do dyskusji czy jest zasadne tworzenie i rozwój tego typu technologii, czy też powinno się raczej skoncentrować na ich absorpcji. Artykuł podkreśla znaczenie Kluczowych Technologii Wspomagających dla UE i przybliża ich kontekst. Autor prześwietla proces wyłaniania inteligentnych specjalizacji, który został nałożony przez UE na Państwa Członkowskie w celu wyłonienia priorytetów na poziomie krajowym lub regionalnym. Główny nacisk został położony na diagnozę (szczególnie na foresight) oraz proces przedsiębiorczych odkryć. Według opinii autora rezultat procesu na poziomie krajowym potwierdza co najmniej aspiracje kraju do rozwoju tego typu technologii.