
The Role of Smart Specializations in Shaping Employee Competencies and Development Practices: Evidence from the Podkarpackie Region

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Abstract:

Purpose: The aim of this study is to examine whether the representation of smart specializations by enterprises in the Podkarpackie region differentiates the assessment of employee competencies, development practices, support mechanisms, and barriers to investing in competence development.

Design/Methodology/Approach: The analysis is based on survey research conducted among employers ($n = 383$) and focuses on selected dimensions of employee qualifications, including specialized, analytical, digital, social, organizational, green, and formal competencies, as well as the organizational context of employee development. The study also considers the nature of development activities undertaken in organizations, the availability of competence development opportunities, and organizational support for employee growth. The statistical analyses were conducted using IBM SPSS Statistics software. Non-parametric methods were applied due to the nature of the data and the potential violation of assumptions required for parametric tests, such as normality of distribution and homogeneity of variance.

Findings: The concept of smart specialization plays an increasingly important role in regional development policy, linking innovation, competitiveness, and human capital development. This study examines whether enterprises representing the smart specializations of the Podkarpackie region differ from other firms in their assessment of employee competencies, development practices, support mechanisms, and barriers to competence development. The results indicate that the relationship with regional smart specializations differentiates only selected aspects of competence assessment and development. Enterprises representing smart specializations report stronger emphasis on specialized competencies and more strategic approaches to employee development, particularly in relation to career paths, transformation processes, and the identification of development needs. At the same time, differences in digital, organizational, and most social competencies are limited, suggesting that these skills have become universal requirements across sectors. The findings imply that smart specializations influence human capital development selectively rather than comprehensively.

Practical Implications: The study contributes to the discussion on the relationship between regional innovation policy and workforce development and provides implications for regional authorities, higher education institutions, and employers.

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Originality/Value: *The literature review indicates a lack of studies combining the topics of smart specializations and competencies. The considerations presented in this paper address this gap in the literature.*

Keywords: *Smart specialization; employee competencies; human capital development; regional development; workforce development; Podkarpackie region; enterprises; competence development.*

JEL Classification: *J24, O15, O18, R11.*

Paper type: *Research article.*

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1. Introduction

In contemporary regional development policy, smart specialization has become one of the key concepts linking innovation, competitiveness, and human capital development. The idea of smart specialization emphasizes the identification and support of those sectors and activities that have the greatest developmental potential within a given region. In this context, the quality of human resources and the ability of employees to adapt their competencies to changing economic and technological conditions play a crucial role.

The Podkarpackie Voivodeship is an example of a region in which smart specializations constitute an important framework for development policy. These specializations include, among others, aviation and aerospace, automotive industry, information and communication technologies, and selected quality-of-life sectors such as sustainable tourism, high-quality food, medical services, and environmentally friendly energy.

At the same time, enterprises operating within and outside these specializations may differ in terms of competence expectations, employee development practices, and the perceived barriers to investing in human capital.

The growing importance of digital transformation, technological change, sustainability requirements, and organizational adaptability increases the need to better understand how firms assess employee competencies and what development

mechanisms they apply. This issue is particularly relevant in regions pursuing smart specialization strategies, where the alignment between labor market needs, education systems, and enterprise development practices may determine the long-term effectiveness of regional growth policies.

The literature indicates that competence development should be analyzed not only in relation to technical and specialized knowledge, but also with regard to analytical, digital, organizational, social, and green skills. Moreover, employee development increasingly requires strategic planning, recognition of competence gaps, and support for both upskilling and reskilling processes. In this sense, enterprises linked to smart specializations may represent a more advanced model of human capital management, although this assumption requires empirical verification.

Therefore, the aim of this study is to examine whether the representation of smart specializations by enterprises in the Podkarpackie region differentiates the assessment of employee competencies, development practices, support mechanisms, and barriers to investing in competence development.

The analysis is based on survey research conducted among employers and is focused on selected dimensions of employee qualifications, including specialized, analytical, digital, social, organizational, green, and formal competencies, as well as the organizational context of employee development.

For the purposes of this paper the term "smart specialization" refers to the region's already established, rather than potential, specializations.

2. Literature Review

In 2009, the Knowledge for Growth Expert Group, established by the European Commissioner for Research, coined the concept of "smart specialization". The idea of smart specialization was to build economic advantage through the development of regional potential in specific fields, technologies, and subsystems (Foray, 2014). In the literature, smart specializations are defined as both a concept and a tool for regional development (Foray, 2009). The assumptions of smart specializations refer to previously known theories, including (Szostak, 2015):

- an endogenous growth theory which assumes that the growth is caused by factors within the studied entity;
- M. Porter's cluster theory which posits that the geographical concentration of interconnected companies, suppliers, and supporting institutions in a given region contributes to a significant increase in innovation and competitiveness;
- H. Innes's primary product theory which suggests that exports of primary products from a given region are a significant factor in long-term economic growth;

- Heckscher-Ohlin's resource abundance theory, which argues that comparative advantage can be shaped by interactions between countries' resources.

In 2010, the European Commission adopted the Europe 2020 Strategy, setting such priorities as: smart growth, sustainable growth and inclusive growth, which resulted in the concept of creating smart specializations of regions. This strategy provides the foundation for regional development policy, based on a place-based innovation policy approach that takes into account sectoral specificities, intersectoral connections, and innovation infrastructure.

This concept aims to strengthen regional potential and create modern development directions consistent with its specific conditions. These activities must be interconnected and aligned with the quadruple helix model: science – education – economy – society (Wolniak, 2016; Walenia, 2021; Pinto, 2022).

The concepts of smart specialization and knowledge-based economy underpin regional development in European Union countries. Innovation, R&D, technological specialization, and specialized knowledge play a fundamental role in this development approach (Pilarska, 2014; ETO, 2025). The concept of smart specialization is key to the development of an innovation (Lyshchikova, 2023).

Efficient implementation of the smart specialization concept should be closely linked to the development of human capital, based on a given region's resources (Przygodzki, 2016).

Countries and regions wishing to benefit from European funds after 2014 were required by the European Union to identify smart specializations. This resulted in national/regional innovation strategies for smart specialization (RIS3).

Regional smart specializations are identified through a process of entrepreneurial discovery. Entrepreneurs play a key role in their discovery, as they, according to the concept, possess the appropriate capabilities to effectively combine scientific and technical knowledge with the resources and potential of a given region (Pilarska, 2014; Asheim, 2020).

The Regional Innovation Strategy of the Podkarpackie Province for 2021-2030 identifies four smart specializations, considered to be areas with the greatest innovation and competitive potential in the region. These are: aviation and space, quality of life, automotive, and information and telecommunications. The sectors representing these smart specializations have the greatest potential to increase competitiveness and develop innovation.

The aviation industry plays a significant role in the economic structure and technological transformation processes in the Podkarpackie Province. Compared to the country and the European Union, the Podkarpackie Province is characterized by

a higher than average concentration of enterprises in the aviation sector and related sectors (defense, electrical machinery, foundry, composite materials), which stems, among other things, from its traditions associated with the electrical machinery industry. The aviation and space sector is the most technologically advanced and innovative industry (RIS, 2022).

The quality of life smart specialization is defined as a set of interconnected sectors whose products and/or services are intended to meet society's needs for improved quality of life. It encompasses numerous industries with varying growth dynamics, including sustainable tourism, high-quality food, medical and fitness-enhancing services and products, and environmentally friendly energy.

A characteristic feature of the quality of life smart specialization is the large number of clusters whose role is to "network cooperation" between associated entities (RIS, 2022).

The automotive smart specialization is related to the broadly defined production of means of transport and the research and development activities carried out in this area. Due to the increasing use of modern technologies in the automotive industry, closer cooperation is expected between regional smart specializations in the automotive and telecommunications and information sectors (RIS, 2022).

The information and telecommunications smart specialization encompasses enterprises operating in the "production of goods and services enabling the electronic recording, processing, transmission, reproduction, or display of information". The assumptions of Industry 4.0 and the dynamics of technological transformation mean that the sectors included in this smart specialization – information and telecommunications – are becoming increasingly important in creating a competitive advantage for the region (RIS, 2022).

The effective implementation of innovations and increased competitiveness are determined by both modern technologies and appropriate employee competencies.

3. Methodology

The statistical analyses were conducted using SPSS Statistic software. Non-parametric methods were applied due to the nature of the data and the potential violation of assumptions required for parametric tests, such as normality of distribution and homogeneity of variance. Non-parametric tests are particularly suitable for ordinal data or when variable distributions deviate from normality (Field, 2018; Conover, 1999).

The Mann–Whitney U test was used to compare two independent groups with respect to the analyzed quantitative or ordinal variable. This test serves as a non-parametric alternative to the independent samples t-test and is based on ranking

observations rather than using raw data values. It allows for the assessment of whether there are statistically significant differences between the distributions of the two groups.

Due to its rank-based nature, the test is robust to violations of normality assumptions (Field, 2018). The Mann-Whitney U test evaluates whether the distributions of two populations are identical. The null hypothesis (H_0) states that there is no statistically significant difference between the two groups, while the alternative hypothesis (H_1) states that there is a statistically significant difference between the two groups.

For comparisons involving more than two independent groups, the Kruskal–Wallis H test was applied. This test represents an extension of the Mann–Whitney U test and serves as a non-parametric alternative to one-way analysis of variance (ANOVA).

The Kruskal–Wallis H test is used to assess whether there are statistically significant differences in the distribution of the analyzed variable across the examined groups, particularly in terms of their central tendency (median). Specifically, it evaluates whether at least one group differs significantly from the others. When statistically significant differences were identified, post hoc analyses were conducted to determine which specific groups differed from each other (Conover, 1999).

Spearman's rank correlation coefficient was used to assess the strength and direction of relationships between variables. This method is particularly appropriate for ordinal data and for situations in which relationships between variables are non-linear.

The coefficient ranges from -1 to 1 , where values close to 1 indicate a strong positive correlation, while values close to -1 indicate a strong negative correlation (Field, 2018).

For categorical variables, the chi-square test of independence was applied to examine associations between variables. This test compares the observed frequencies with the expected frequencies under the assumption of independence. A statistically significant result indicates the existence of a relationship between the analyzed variables (Agresti, 2007).

It should be noted that non-linear relationships may not always be fully captured by correlation measures. Nevertheless, Spearman's coefficient provides a robust approach for analyzing ranked data without requiring strict distributional assumptions.

Similarly, the chi-square test is based on the assumption of independence and evaluates its validity through the comparison of observed and expected frequencies, allowing for the identification of statistically significant associations.

4. Research Results

This section of the article will present the key research findings, which will serve as the basis for further discussion.

The study involved 383 employer representatives from the Podkarpackie Voivodeship operating in manufacturing, services, or trade. However, 42.8% of respondents stated that their business activities did not fall within the scope of the smart specializations of the Podkarpackie Voivodeship.

The sampling was based on quotas, proportionally distributed across the districts, according to the number of enterprises meeting the study's objectives. Respondents were employers – owners, board members, and top managers. The study was quantitative in nature, and the research techniques used were CATI and CAWI.

Based on basic data quality control, the dataset was found to be complete and free from significant gaps. The analysis of the survey completion time revealed no irregularities that could indicate unreliable responses. No duplicates were identified in the dataset. A check of the variable ranges confirmed their accuracy and compliance with the adopted assumptions.

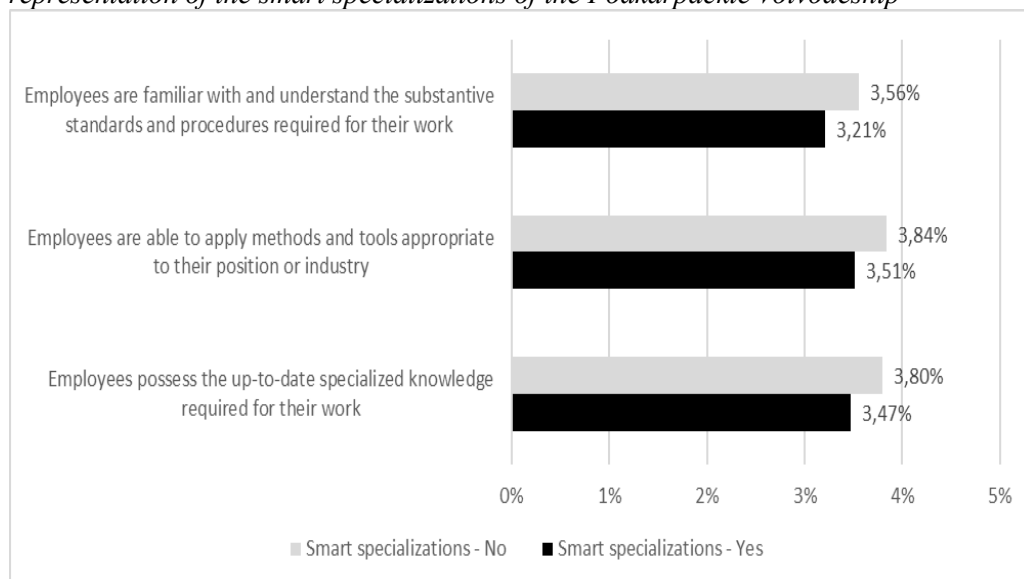
Respondents were asked to assess the current level of specialized (subject-matter/professional), analytical, digital, social and communication, organizational and project management, green, and formal competencies among all employees, as well as the level that will be required in five years' time.

The responses were analyzed in relation to the question of whether the company's activities align with the smart specializations of the Podkarpackie Voivodeship. The Mann-Whitney U test was used for the analysis. The results regarding the relationship between smart specializations and the assessment of specialized qualifications are presented in Figure 1.

Companies representing the smart specializations of the Podkarpackie Voivodeship's generally rate their employees' specialized qualifications higher than other companies. Statistically significant differences primarily concern the current level of specialized knowledge ($p=0,008$), the ability to apply industry-specific methods and tools ($p=0,002$ and $p=0,017$), knowledge of standards and procedures ($p=0,033$), and some assessments regarding the level required currently and in the next 5 years ($p=0,044$ and $p=0,027$). In both groups, the highest ratings relate to the level expected in 5 years, indicating the growing importance of specialized competencies.

Companies representing the smart specializations of the Podkarpackie Voivodeship's rate their employees' analytical skills lower than other companies. Statistically significant differences are observed in the level currently required ($p=0,007$).

Figure 1. *Specialized qualifications (disciplinary/professional) and the company's representation of the smart specializations of the Podkarpackie Voivodeship*



Source: *Own research.*

The fact that the company represents the smart specializations of the Podkarpackie Voivodeship's does not significantly affect employees' digital skills. In all analyzed areas - information search and evaluation, the use of digital tools for collaboration and communication, data security, and improvements in work efficiency through digital tools - no statistically significant differences were found between the groups.

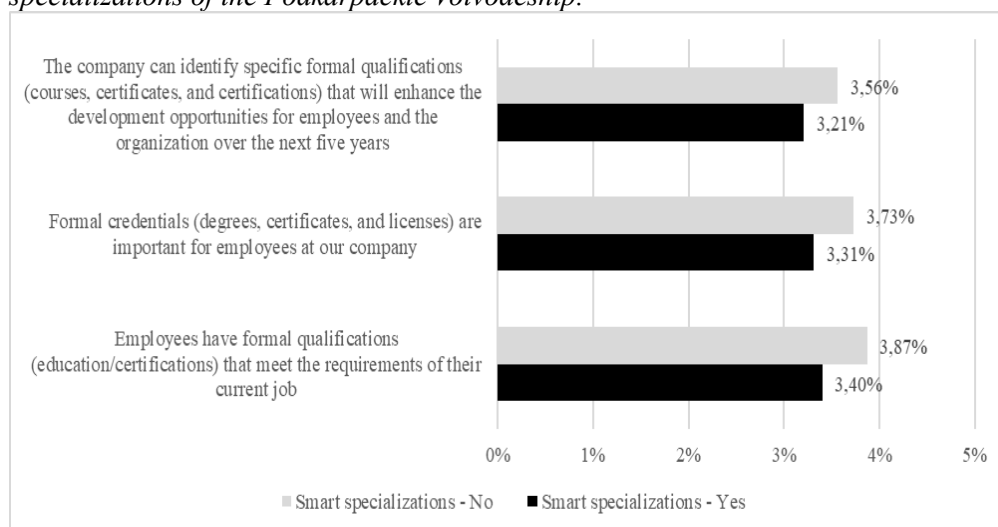
Social and communication skills are rated lower by companies representing the smart specializations of the Podkarpackie Voivodeship than by other businesses. Statistically significant differences concern teamwork and coordination skills: the current level ($p = 0.047$), the level currently required ($p = 0.028$), and, at the margin of significance, the level expected in five years ($p = 0.050$).

The fact that the company represents the smart specializations does not significantly affect the organizational and project-related qualifications of its employees.

With regard to employees' "green" qualifications, the only statistically significant difference concerns the current level of knowledge and application of environmental requirements and standards-higher scores were recorded in companies that do not specialize in this area ($p=0,037$).

Companies not involved in the smart specializations of the Podkarpackie Voivodeship's rate the adequacy of their employees' formal qualifications more highly than companies involved in those specializations (Figure 2).

Figure 2. Formal qualifications and the company's representation of the smart specializations of the Podkarpackie Voivodeship.



Source: Own research.

Statistically significant differences concern the current level ($p < 0,001$), the level currently required ($p = 0,008$), and the level expected in 5 years ($p = 0,041$) in terms of the adequacy of formal qualifications. Significant differences were also noted regarding the importance of formal credential as the current level ($p = 0,001$) and the company's ability to identify the necessary credentials ($p = 0,003$).

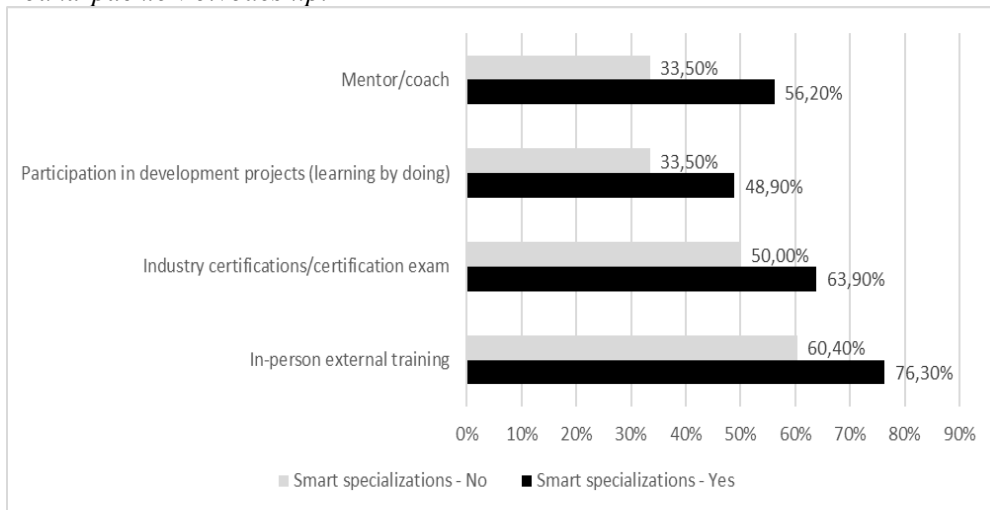
The next questions asked of respondents concerned the employee development programs offered or funded by the company over the past 12 months, as well as an assessment of the nature of the development activities offered to employees during that period. The responses were analyzed in relation to the question of whether the company's activities align with the smart specializations of the Podkarpackie Voivodeship.

The Mann-Whitney U test was used for the analysis. The results concerning the relationship between the responses of representing smart specialization and the forms of employee development offered or funded by companies, as well as the nature of these development activities, are presented in Figures 3 and 4.

The fact that a company represents the smart specializations of Podkarpackie Voivodeship has influenced the types of employee development programs offered or funded by the company over the past 12 months (Figure 3). Employees of companies representing such specializations significantly more often cited external (in -person) training ($p = 0,001$), industry certifications/certification exams ($p = 0,006$), participation in development projects (learning-by-doing) ($p = 0,003$), and mentoring/coaching ($p = 0,001$).

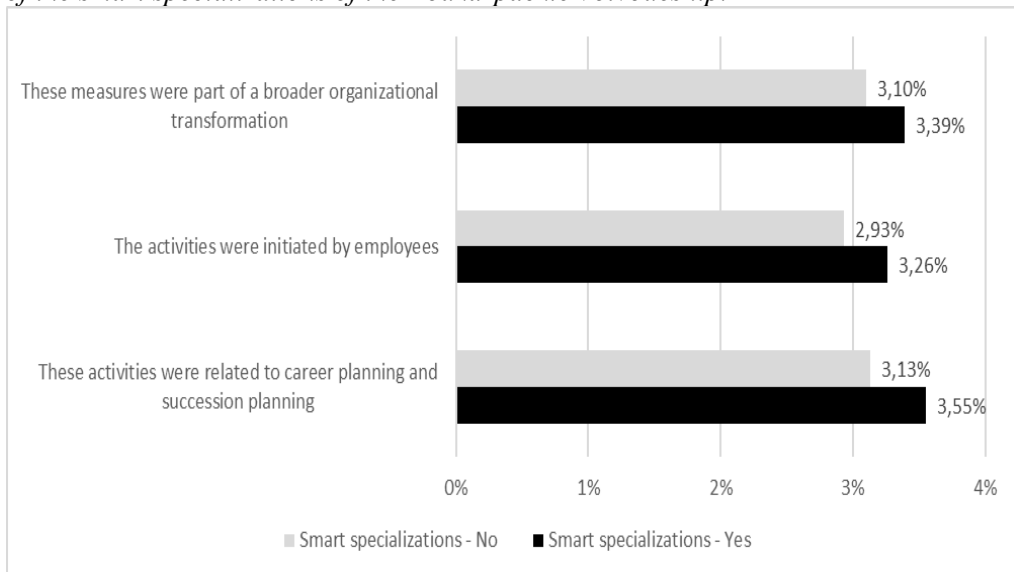
The results of the study indicate the presence of statistically significant differences in area related to the strategic aspects of employee development management (Figure 4).

Figure 3. *Forms of employee development offered or funded by companies in the past 12 months and their representation of the smart specializations of the Podkarpackie Voivodeship.*



Source: Own research.

Figure 4. *The nature of professional development initiatives implemented by organizations for their employees over the past 12 months and their representation of the smart specializations of the Podkarpackie Voivodeship.*



Source: Own research.

Statistically significant differences concern development activities related to career path and succession planning ($p=0.001$), employee initiated activities ($p=0.008$), and those that are part of a broader organizational transformation ($p=0.017$). In all cases, higher values were recorded in companies representing the smart specializations of the Podkarpackie Voivodship.

However, the fact that a company represents the smart specializations of the Podkarpackie Voivodeship does not significantly affect the assessment of the availability of skills development opportunities in the region. Whether in terms of forms that support the improvement and deepening of employees' competencies within their current roles or those that prepare employees to take on new roles or changes in their scope of duties, no statistically significant differences were found between the groups (in all cases, $p>0.05$).

The results of the study indicate no statistically significant differences between companies representing smart specializations and other enterprises in terms of employer support for employee development. The only statistically significant difference, indicating more mature employee development management, concerns the existence of a clear process for identifying development needs ($p=0.006$); a higher score was recorded in companies representing smart specializations.

Companies representing smart specializations invest in employee development primarily to prepare them for new roles or organizational changes ($p=0.039$), whereas companies not representing smart specializations more often cite compliance with regulatory or industry requirements as their motivation ($p=0.041$).

5. Discussion

Previous research on smart specializations has focused primarily on the analysis of innovation ecosystems, industry-university collaboration, R&D activities, and sustainable development (Aralica *et al.*, 2022; Tomasi *et al.*, 2022; Buyukyazici, 2023; Roncevic, Ostojić, 2023; Rodríguez Ochoa *et al.*, 2025). A review of the literature indicates a lack of studies linking the topic of smart specializations with competencies. The discussion presented in this article fills gap in the literature.

The results of this study provide important insights into the role of regional smart specializations in shaping human capital development within enterprises. The finding that companies representing smart specializations place greater emphasis on specialized competencies is consistent with the literature on knowledge-based economies, where sector-specific skills and expertise play a critical role in maintaining competitiveness.

At the same time, the relatively lower assessment of analytical competencies in these firms may suggest that more advanced problem-solving skills are required, which are not yet fully developed among employees.

The lack of significant differences in digital and organizational competencies indicates their increasing standardization across industries. This supports the argument that such competencies are no longer a distinguishing factor but rather a basic requirement in modern labor markets (Lemke, 2002).

An interesting observation concerns formal qualifications, which were rated higher in companies not aligned with smart specializations. This may suggest that firms operating outside key regional sectors rely more heavily on formal certification systems, while companies within smart specializations may prioritize practical skills and experience.

Companies representing smart specializations rate their employees' soft skills lower than other companies. This may be due to the fact that such companies foster an organizational culture based on expert knowledge and place greater emphasis on technical skills. Research by a team from the Białystok University of Technology indicates a skills gap between the current state and the desired state. In the research conducted by the team, companies representing smart specializations note that, in their view, when it comes to implementing innovation, soft skills are more important than professional skills as a key competencies (Glińska *et al.*, 2024).

Furthermore, the more strategic approach to employee development observed in firms representing smart specializations, particularly in terms of career planning and employee engagement, confirms their stronger orientation toward long-term organizational growth and transformation. This is also demonstrated by sector-specific studies and analyses (dos Santos, 2018; Fonseca, 2021; Kogut-Jaworska, 2024).

However, the limited differences in perceived barriers and access to training opportunities indicate that systemic constraints, such as time pressure or financial limitations, affect enterprises regardless of their sectoral alignment.

Overall, the results suggest that while smart specializations play a role in shaping certain aspects of competence development, their influence is selective rather than comprehensive. This highlights the need for more integrated regional policies that support not only sector-specific skills but also transversal competencies critical for future labor markets.

6. Conclusions

The conducted analysis indicates that the relationship between enterprises and the smart specializations of the Podkarpackie region only partially differentiates the competencies and development practices of employees. Firstly, companies representing smart specializations generally report higher levels of selected specialized competencies, particularly in terms of current knowledge, the use of professional tools, and familiarity with standards and procedures.

At the same time, both groups of firms emphasize a further increase in the importance of these competencies in the next five years, which reflects growing demands related to technological and economic changes.

Secondly, enterprises operating within smart specializations tend to assess analytical and problem-solving competencies of employees slightly lower compared to other firms, especially in terms of data analysis and drawing conclusions. This may indicate higher expectations or more demanding operational environments in these sectors.

Thirdly, no significant differences were observed in the case of digital, organizational, and most social competencies, suggesting that these skills are becoming universal requirements across sectors, regardless of their alignment with regional smart specializations. Moreover, firms representing smart specializations demonstrate more structured approaches to employee development, particularly in terms of career path planning, employee-initiated development activities, and alignment with broader organizational transformation processes.

Finally, the analysis reveals that the alignment with smart specializations has a limited impact on barriers to competence development, as well as on the availability of training opportunities in the region.

7. Recommendations

The findings of this study imply several directions for regional and organizational policy aimed at strengthening competence development in the context of the Podkarpackie region's smart specializations.

First, regional policy should place greater emphasis on supporting the development of specialized and analytical competencies, as these appear to be particularly relevant in enterprises linked to smart specializations. Although firms operating in these sectors report relatively strong domain-specific knowledge, the lower assessment of analytical skills suggests a need for targeted initiatives that promote data analysis, problem-solving, and evidence-based decision-making.

Second, cooperation between universities, training providers, and enterprises should be strengthened in order to better align educational offers with the competence needs of regional employers. This is especially important in sectors connected with smart specializations, where competence requirements are likely to evolve rapidly due to technological and organizational change.

Third, public support instruments should encourage enterprises to adopt more strategic and long-term approaches to employee development. The results show that firms representing smart specializations are more likely to link development activities with career paths, organizational transformation, and employee initiative.

These practices should be disseminated more broadly through regional development programs, good practice exchange, and financial incentives for competence planning.

Fourth, policy interventions should not be limited only to highly specialized sectors. Since digital, organizational, and many social competencies do not differ significantly between firms representing and not representing smart specializations, these transversal skills should be treated as a common foundation of workforce development across the entire regional economy.

Finally, regional authorities should improve the accessibility and responsiveness of competence development offers, ensuring that training opportunities are flexible, practice-oriented, and adapted both to current job roles and future organizational needs. A more integrated approach combining sector-specific and transversal competencies may strengthen the adaptability and long-term competitiveness of enterprises in the region.

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