

**CHALLENGES OF INNOVATION DEVELOPMENT
BASED ON SMART SPECIALIZATIONS IN THE CONTEXT
OF HUMAN RESOURCE CAPACITY BUILDING –
ON THE EXAMPLE OF HYDROGEN TECHNOLOGY COMPANIES**

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Purpose: The concept of smart specialization refers to the identification of specializations in areas of potential competitive advantages, for which it is necessary to link the scientific and research spheres with the economy and properly focus processes and resources on building the innovative potential of enterprises. The purpose of this study is to assess the importance of human resource potential in the development of innovation of enterprises implementing hydrogen technologies within selected specialized economic areas of so-called smart specializations. In the search and identification of the research gap, it was assumed that the implementation of hydrogen technologies, can certainly be counted among the activities covered by the support of regions interested in innovation, since these technologies are or are now becoming priorities of EU energy policies. Hydrogen technologies are considered to be technologies of the future, forward-looking and strongly innovative, making them perfectly compatible with the concept of smart specializations. Filling the research gap in current research on smart specializations, which includes an analysis of human resource capacity building in the face of the remaining challenges facing hydrogen technology companies, therefore seems to be a particularly interesting issue.

Design/methodology/approach: An analysis based on a quantitative survey conducted on a sample of 150 companies in the energy sector related to the development and deployment of hydrogen technologies was used to achieve the research objective. The study used logistic regression, which is a statistical method of analysis used to model the probability of a binary event. The purpose of using this type of regression was to identify and assess the significance of the determinants of the performance of the companies studied.

Findings: The study found that the approach to human resource capacity building for the implementation of smart specialization strategies is changing. The results indicate that human resources and human resource potential of enterprises are crucial for the development of innovation, and this is one of the most important challenges of the future for the surveyed enterprises.

Originality/value: The analyses carried out within the framework of the work clearly confirm the direction of activity of hydrogen technology companies within the framework of smart specialization strategies and at the same time indicate that the topic is a niche one, entering a phase of intensive development.

Keywords: Smart specializations, human resource potential, innovation, energy, hydrogen technologies.

Category of the paper: Research paper.

Introduction

Smart specializations being an integrated and territorially oriented set of activities, tools, public resources contribute to economic transformation. Influencing structural transformation and the creation of innovative socio-economic solutions, they support the transformation towards a resource-efficient economy (Ministerstwo Rozwoju, 2020), including human resources.

The literature indicates that smart specializations are based on technological innovation, stimulate private sector investment, taking into account key priorities, challenges and economic needs (Foray, Mowery, Nelson, 2012). Combining know-how with innovation-oriented resources achieves related diversity within new products and market niches (Novosak et al., 2013). It helps, also adopting an outward orientation and using existing potentials to create competitive advantages used in building the innovative capacity of enterprises. Relevant here is the transformative function of policy implemented through highly selective policy interventions focused on specific types of economic activity (Gianelle et al., 2020). The effectiveness of the policy depends on the willingness, ability and cooperation of all participants, i.e. entities representing the public administration, business, science and business environment institutions (Aranguren, Navarro, Wilson, 2015).

Although the processes of creating and implementing regional smart specialization strategies are widely discussed in theory (among others: David, Foray, Hall, 2009; Gemma, Bulderberga, 2017; Uyarra, Marzocchi, Sorvik, 2018; Weidenfeld, 2018; Gianelle, Guzzo, Mieszkowski, 2020; Uyarra et al., 2020; Ghinoi et al., 2021; Ferreira et al., 2021), there is, however, still research on the effects of their implementation and the effects they bring to businesses and the environment in which they operate. It also becomes crucial to verify whether the implemented tools meet the needs of entrepreneurs and under what conditions these implementations would have the best effect (the issue was described: Kogut-Jaworska, Ociepa-Kicińska, 2023a; 2023b) and whether, in view of the current challenges of innovation development, research and development activities, the importance of human capital and human resource capacity building play a leading role.

It should also be pointed out that recently there has been growing interest in hydrogen technologies in conjunction with innovation policy. Extensive research in this regard has been presented by, among others: Ortiz Cebolla, Rafael & Navas, Carlos (2018). The authors pointed out that economies are moving away from energy derived from hydrocarbons, and hydrogen is an effective alternative for them, which is of interest to policymakers creating policies to support innovation. In addition, the use of hydrogen technology in modern economies, mainly in the energy and transportation sectors, is aimed at halting the progressive greenhouse effect, and is part of many strategic documents, including one of the pillars of the implementation of the European Green Deal, whose goal is for Europe to achieve climate neutrality by 2050.

It should be emphasized that the European Commission's 2020 Hydrogen Strategy. EU Hydrogen Strategy (Hydrogen Strategy for a Climate Neutral Europe, 2020) prioritizes the development of renewable, green hydrogen, produced by electrolysis using renewable energy sources (Ortiz Cebolla and Navas, 2019).

In the search for and identification of the research gap, it was assumed that the implementation of hydrogen technologies, can certainly be counted among the prospective activities covered by the support of regions interested in innovation, since these technologies are or are now becoming priorities of EU energy policies. Hydrogen-based technological solutions offer a number of opportunities, especially with regard to the transportation and industrial markets, and in particular the energy market, which faces very ambitious goals and operates in a dynamically changing environment. Energy and environmental safety issues are constantly being redefined here. Although, increasingly in practice, hydrogen technologies are creating new conditions for companies operating in traditional regional arrangements, forcing change and operating within the framework of network connections, the literature lacks analyses linking and describing these phenomena. On the one hand, it can be noted that hydrogen technologies create innovation potential and become the main directions of smart specialization strategies implemented in the regions, but on the other hand, they are new enough to gain an established position as the subject of separate studies on stimulating their development as specialized industries in innovation-supporting regions.

The main research objective of the study was to assess the importance of human resource capacity building in the development of innovation of enterprises implementing hydrogen technologies within the framework of smart specializations. In the area of smart specializations related to, for example, energy or hydrogen technologies, human resources, the size, structure of labor resources, but also their quality, may prove to be a particularly interesting issue for conducting assessments and conclusions.

Methods

Innovation management processes in the regions, particularly in relation to smart specialization strategies, with a particular focus on EU innovation policy and hydrogen technologies, were the subject of a survey. The survey was carried out by survey method, using CATI (Computer-Assisted Telephone Interview) and CAWI (Computer-Assisted Web Interview) survey techniques in the second half of 2023. The research tool used was a developed questionnaire with a total of 12 closed-ended and semi-open-ended questions, and they were either single-choice or multiple-choice in nature. The study used a measurement scale - a Likert scale with information flowing through extreme values (e.g., on a scale of 1 to 5, then 1 means "no challenge" and "5" means "very challenging"). The database developed for the survey

consisted of 200 records, and during the survey the database was expanded by 50 records in order to reach the desired number of respondents, i.e. $n = 150$ business entities representing the energy sector (according to the PKD).

To determine the research sample, data from databases were used Kompas International and Business Navigator. Entities meeting the criteria for the survey were selected from them. Due to the identification of the group of respondents in terms of their activities, the sample selection was made on the basis of the identification of the leading PKD code (selected divisions: Section D - generation and supply of electricity, gas, steam, hot water and air for air conditioning systems; Section C - manufacturing, G - wholesale and retail trade, repair of motor vehicles, including motorcycles; M - professional, scientific and technical activities).

The study used logistic regression, which is a statistical method of analysis used to model the probability of a binary event. The purpose of using this type of regression was to identify and assess the significance of the determinants of the studied companies' performance. The analysis was carried out at a predetermined level of alpha (α) = 0.05, which established a 5% risk of Type I error. The normality distribution of the numerical variables was assessed using the Shapiro-Wilk test. Descriptive statistics summarized the characteristics of the data. In the case of numeric variables, these included: central tendency and measures of location. Median (Mdn) was reported as a measure of central tendency that was robust to outliers and skewed distributions. The first (Q1) and third (Q3) quartiles were presented to describe the spread of the data and identify the central 50% of values.

Results

Assuming that the employee's potential (ang. employee's potential) is the combined action of both the qualities and competencies of a particular employee (and thus his or her health, abilities, general and professional knowledge, practical skills, level of moral development, motivation for work and continuous personal development, acquired experience of behavior contributing to the satisfaction of the requirements of the environment especially in new work situations (Encyklopedia Zarządzania, 2023), it should be assumed that the sum of the potentials of all employees will constitute the desired human resource potential of the enterprise. Building human resource potential (or more broadly, human capital management) will therefore concern the acquisition of employees with the highest possible qualities (potential), and the construction of a system of investment in employees aimed at constantly improving their skills.

An analysis of the presented summary (see Table 1) indicates a number of challenges that companies in the energy sector will need to address in their future operations in the context of innovation growth in the next five years. The average ratings of the challenges are in the range of 3.00 to 4.00, which signals that respondents consider these issues important but not critical.

Table 1.

Assessment of selected challenges that will have the greatest significance in the next 5 years for the company's activities in the context of innovation growth

Characteristics	N	Mdn (Q1, Q3)
High competition in the global market	150	4,00 (2,00, 4,00)
High competition in the domestic market	150	4,00 (3,00, 5,00)
Insufficient human resources potential due to lack of employees with expected qualifications	150	3,00 (2,25, 4,00)
High costs of conducting R&D for the introduction of new technologies	150	3,00 (2,00, 4,00)
Limited access to external financing (e.g. loans, credits, grants)	150	4,00 (3,00, 5,00)
High non-operating costs of doing business (e.g., taxes, fees, rental costs)	150	4,00 (3,00, 5,00)

Source: compiled from own research.

The analysis shows that high scores for the challenges of high competition in both the global and domestic markets (both 4.00) may indicate the intensity of the rivalry that companies face. The surveyed companies are aware of the future competitive struggle in the sector, suggesting the need to implement differentiation strategies, such as investing in unique technologies, including hydrogen technologies, building strong brands, and focusing on innovation and product quality to stand out from competitors.

A significant challenge for respondents turns out to be insufficient human resources potential (3.00), which in turn indicates a skills gap. This challenge indicates the need to make investments in the development of human capital, including ensuring that employees participate in training programs, studies and internships, which involves extensive cooperation with academic centers. These activities relate to processes related to attracting and retaining employees with the right skills. The challenge of the high cost of conducting R&D (3.00), on the other hand, requires companies to seek cost-effective methods of innovation, carried out, among other things, through such activities as forming strategic partnerships, cooperating with scientific entities or taking advantage of subsidies dedicated to R&D activities.

Surveyed representatives of enterprises considered limited access to external financing (4.00) as a significant challenge in the coming years, suggesting the need to develop the ability to raise capital through a variety of sources, such as venture capital funds, innovation support programs or alternative forms of financing. In the context of the analyzed inadequate human resource potential related to the lack of employees with the expected skills, limited access to financing can be treated as an acute barrier further limiting the filling of the potential skills gap. High non-operating costs (4.00) is an issue that may hinder the development of enterprises, requiring them to optimize costs and effectively manage their finances, as well as possibly restructure operations to reduce the financial burden.

Discussion

All of the indicated challenges will significantly determine the adaptation of energy companies to a turbulent environment in the future, which will also be influenced by innovation development policies, including smart specializations that develop the innovative potential of regions. The competitive position in the market can be largely shaped by investments in human capital, which, in turn, can be of comparable importance for companies as investments in advanced technologies or investments in technical infrastructure.

Conclusions from the analysis carried out on the basis of the collected empirical material allow us to conclude that in the context of human resource capacity building, there is a need to implement integrated management strategies in enterprises that will focus on implementing innovative solutions, attracting and retaining well-prepared employees and effectively managing costs. These conclusions are consistent with the statements Gemma and Bulderberga (2017) and Uyarra, Marzocchi and Sorvik (2018), presented in the aforementioned literature, who emphasize the importance of developing smart specializations in the context of various challenges. It is becoming crucial for the surveyed companies to seek new methods of financing their activities, which will allow them to make investments in new technologies and R&D, while at the same time it will be important to meet future personnel needs, which will require a differentiated approach to human factor management (e.g., reaching for personnel resources represented in network arrangements, or resources coming from abroad along with acquired technology).

Taking into account the fact that nowadays the strategic resource of an organization is the potential of its employees, companies should strive to constantly improve its quality. Filling the research gap indicated in the introduction, it should be emphasized that in the case of the implementation of hydrogen technologies by companies in the energy industry, they can oscillate around such issues as hydrogen energy, renewable energy sources and renewable energy technologies, renewable and mineral resources management, renewable energy engineering, renewable energy sources and waste management.

Summary

The analysis carried out leads to the conclusion that changes in the environment of modern enterprises related to the constant competitive struggle, force a change in the way of looking at the existing standards of human resource management and generate new challenges in this area. In the context of the research objective defined in the introduction indicating the assessment of the importance of human resources potential in the development of innovation of companies

implementing hydrogen technologies within the framework of the so-called smart specializations, it should be stated that companies implementing new technologies recognize the need for employees to have specific skills and knowledge, thus increasing the importance of building human resources in innovative business.

In the context of the undertaken issue of building the human resource potential of enterprises and the challenges for the development of innovation based on smart specializations facing these enterprises, it should be further indicated that an essential element of public action in the near future will be the formation of high-quality human capital, at all levels and stages of education. This will make it possible to positively influence emerging spaces in the demand for human capital matched to the current state of technological advancement, which is an ongoing challenge. Other challenges that will be faced by entities identifying and implementing smart specializations will undoubtedly include raising the quality of personnel employed in enterprises (employees who generate value that is a source of competitiveness), the organization and distribution of financial resources to support the processes of increasing competitiveness, and attention to the effectiveness of the actions taken.

In conclusion, it should be pointed out that building human resource potential is perceived by the surveyed entrepreneurs as one of the dominant challenges for the future, and the limited level of this potential as a significant barrier to development. Both the challenges for the future and the barriers limiting the development of human resources potential, due to their significant importance for the development of innovation based on smart specializations, should be a constant element of analysis and an invariable direction of future research. In terms of thinking about smart specializations in regions where there are generally noticeable losses in population potential and where processes of population aging are evident, the formation of high-quality human capital, at all levels and stages of education should permanently be a priority objective of the long-term development strategy.

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