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The regional environment of smart organisations as a source for entrepreneurship development in the EU

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ABSTRACT

Objective: The objective of this article is to investigate the relationship between the wealth of the regional environment of a smart organisation and the entrepreneurship level, based on examples of EU regions.

Research Design & Methods: This article is based on a quantitative, cartographic analysis combined with a critical analysis of the literature on the subject. Using the method of linear ordering of standardised summary data based on data for European regions, an innovative model of smart IT resources, knowledge and relationships were developed to study their impact on the development of entrepreneurship and innovative enterprises. The model was tested for three groups of firms: in general aggregation, groups engaged in product innovation, and groups engaged in business innovation. The study covered data for 240 regions from 22 EU member states.

Findings: The literature lacks a clear definition and measurement methods for smart organizations. The most important resources for their development are relational, IT, human and Research and Development capital, which are also crucial for modern companies. There is no correlation between a region's prosperity and overall entrepreneurship, but there is a clear link between high potential for smart organization development and smart business development. Research shows a link between innovative enterprise development and IT, relational capital and scientific research capital.

Implications & Recommendations: Smart organizations in innovative environments drive socioeconomic development through technological entrepreneurship and digital equivalents of traditional products and services. Digitalization of the economy through smart organizations is crucial for micro and meso-level competitive advantage. To identify key mechanisms, public statistics must be adapted to the needs of the digital economy.

Contribution & Value Added: This article proposes measuring the relationship between regional potential for smart organizations and entrepreneurship, with a new methodology and approach to support regional management in digitalization. It highlights that IT, human, and research and development capital are key factors for entrepreneurship, and offers a new definition of entrepreneurship. The article also identifies a research gap in the theory of locating innovative enterprises.

Article type: research article

Keywords: smart organisation; entrepreneurship; development potential; EU regions; location; innovative enterprise

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INTRODUCTION

Entrepreneurship is one of the most important determinants of economic development because of its impact on employment, innovation, and productivity. For the development of entrepreneurship, the environment in which firms are created and operate is of great importance. This environment consists of tangible elements (*e.g.*, firms and infrastructure), intangible elements (*e.g.*, skills and knowledge),

and institutions, including, for example, power at various levels. This authority can actively shape the conditions for startups and strengthen pro-entrepreneurial attitudes.

This is especially important in the VUCA environment, *i.e.*, volatility, uncertainty, complexity, and ambiguity (Bennett & Lemoine, 2014), in which companies currently operate. Furthermore, the ongoing globalisation and related scientific and technological advances are leading to changes in the perception and manifestations of entrepreneurship, which requires a change in the approach of public administration to promote entrepreneurship. Under these new conditions, public administration units operating at different levels (regional, local, national) are looking for ways to improve their activities, which consist in meeting the needs of local development actors, including, for example, entrepreneurs and investors. One such way is the smart organisation of the public sector, which can help to better adapt to ongoing changes and take advantage of opportunities that arise, for example, in the technological field. The research in this article was conducted at the regional level in the EU.

According to Florida (1995), regions must learn by attracting resources and then organising them. The endowment of the region with resources (capital) conducive to the creation of regional intelligent organisations can influence the possibility of promoting the creation and development of modern enterprises. Therefore, the aim of the article was to investigate the relationship between the wealth of the regional environment of a smart organisation and the level of entrepreneurship, using EU regions as an example. The level of entrepreneurship was understood as the number of entrepreneurs registered in the REGON register in the area of local government units (Derlukiewicz *et al*., 2021). Noteworthy, there are no studies in the literature on the relationship between the wealth of the regional environment of smart organisations and the level of entrepreneurship in the region. This indicates a knowledge gap that this study attempts to fill. Moreover, the article identifies a methodological gap in the literature regarding the definition and measurement of a smart organisation in the region, so this study will provide a proposal to fill this gap.

The study attempted to answer the following research questions:

1. How is a smart organisation defined in the region and what are its features and metrics?
2. What are the main resources (potential) required for the development of smart organisations in the region?
3. What are the relationships between the resources of the regional environment of smart organisations and the level of entrepreneurship?

The first part of the study will present the definitions of smart organisations in the region and the existing methods of measuring smart organisations in the region based on the methods of measuring smart cities. The next part of the study will identify the current conditions for the development of entrepreneurship in the context of new approaches to the definition of this phenomenon, followed by a look at the research method used. The results of the research will be then presented and discussed, and the article will end with the conclusions drawn from the conducted research.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Definitions of Smart Organisation and Their Specificity in The Public Sector Organisation and Regional Environment Context

An early predecessor of the smart organisation is the learning organisation pertaining to the ability to create, acquire, and transfer knowledge within its boundaries, and an ability to modify organisational behaviour in a way reflecting knowledge and insights (Garvin, 1993).

Information and the ability to use it in the right way at the right time started to become perceived as the competitive advantage of an enterprise, and thus, knowledge management, as a domain in both scholarly and real economy contexts, gained importance. A specific type of learning organisation, one advancing and mastering organisational learning ability, is an ambidextrous organisation and it is characterised by the parallel between two types of learning, *i.e.*, exploitative learning enabling to improve and advance existing organization's capabilities and resources and exploratory learning oriented on

monitoring the organizational environment and identification and acquisition of relevant new insights and knowledge (He & Wong, 2004).

According to Yolles (2006), organizational processes related to self-awareness of the organization's condition, within the context of acquiring new knowledge for competitiveness, are crucial differentiating factors among intelligent, ambidextrous, and learning organization types.

Compared to learning organizations, smart organizations exhibit a greater emphasis on a clearly defined purpose and the stakeholders they serve, utilize feedback loops to enhance learning, and employ technology solutions for data analysis and operations. According to scholars, smart organisations are knowledge-driven, interworked, and dynamically adaptive organisational forms, which practice learning and agility to stay customer-focused and to master change and uncertainty (Filos & Banahan, 2001). Filos (2006) indicates that smart organizations define their activities based on knowledge and they exploit the knowledge to respond to concrete market opportunities within the reach of the organization. Other scholars outline that smart organisations highly depend on the customer's feedback and organise tasks linked to specific processes and goals to respond to both dynamic patterns of consumers' needs and expectations and workers' skills and availability (Iapichino *et al.*, 2018).

The most recent definitions of smart organisations highlight the importance of monitoring the organisational environment and operations, creating collaborative networks that enhance reactive and proactive organisational capabilities, and leveraging technological and human resources to become sustainable in the environmental, economic, and social aspects (Sousa *et al.*, 2020). Smart organisations are also defined through a combination of expertise provided by human resources with the support offered by technology-based platforms (Adamik & Sikora-Fernandez, 2021).

To summarise, smart organisations prioritize a clearly articulated organizational purpose that goes beyond mere existence or survival, depend on relevant organisational stakeholders' feedback, exploit existing organisational knowledge to leverage the ability to fulfil the organisational purpose, explore new, non-existing organisational knowledge to serve relevant organisational stakeholders, are dynamically adaptive, adopt an interworking approach, use collaborative and leveraging support of technology-based solutions and other tools for purposeful utilisation of information and data for its operations.

The smart organisation, compared to the type of smart organisations studied for over three decades in managerial and engineering sciences (Lopez-Roblez *et al.*, 2019), is more oriented on the purpose, the stakeholders it serves, and the feedback loops it uses to enhance learning. It also uses technology in data analysis and operations, which is an aspect we can attribute to this specific organisation type.

The public sector, which is the context of smart organisations in this article, consists of entities owned and reporting to the state, local and regional self-governments, or self-government entities, in which most of the ownership and equity can be attributed to public entities. By its nature, the public sector focuses primarily on satisfying the needs and legal entitlements of the stakeholders its serves, rather than the economic profits. In this article, we focus on public sector organisations responsible for governance over given local and regional administrative-territorial units and the provision of defined public goods and services.

Therefore, a smart organisation in the public sector should be directed towards satisfying the needs of the local development stakeholders it serves, such as residents, investors and entrepreneurs, and other features related to the nature of the public sector. The smart organisation analysed in this article derives from its location in a concrete environment and the resources it possesses within that environment, which influence the development potential and maturity level smart organisations demonstrate. Wereda (2010) defines a smart organisation in the public sector as an organisation providing employees with education and skills improvement opportunities, searching for effective and innovative sources of finance, implementing changes to respond to market megatrends, and encouraging new economic entities and residents to settle in its territory by leveraging its brand and local government fiscal and financial incentives, leveraging education and the skills of its citizens.

Moreover, scholars outline the capacity of smart organisations in the public sector to generate and manage knowledge, including its utilization in executing public tasks, by being creative and innovative in problem-solving, capable of forecasting social needs, and flexible in responding to them (Sikora-Fernandez, 2013). One of the discursive definitions of smart organisations in the public sector defines

it as an organisational way of working within public sector units that effectively manage information, knowledge, communication, and relations with partners, leverage technology to deliver upon public tasks, and dynamise local development processes to achieve and maintain competitive advantages (Godlewska-Majkowska & Komor, 2019).

This definition directly highlights the importance of relational, IT, and human capital as key resources needed to develop smart organisations in the region. Indirectly, this definition emphasises the role of scientific and research capital in the development of smart organisations in regions, because it creates knowledge in the region, is an institution that trains personnel, for example for public administration, and is an important partner that collaborates with public administration to drive development processes in a given area. It can be concluded that among the most important resources (potential) required for the development of smart organisations in the region, the following are particularly important: relational, IT, human, and research and development capital, which are the answer to the second research question, and were analysed in the empirical part of this article at the regional level in the EU.

Existing Methods of Assessing Smart Organisation in The Public Sector Organisation and Regional Environment Context

The popularisation of the phenomena of smart cities and smart municipalities in the last decade in the European Union raises the question of whether and to what extent smart organisations in the public sector overlap with them. Smart cities are defined through the specific capability to utilise information and communication technologies to increase citizens' quality of life. Smart cities are often discussed within the context of urban planning and governance, where technology solutions play a crucial role in collecting, processing, and utilizing data from various municipal networks and installations. These installations can include parking spaces, traffic lights, water supply systems, sewers, and public monitoring systems. The aim of incorporating technology in this manner is to enhance and improve urban planning, urban management, and governance practices (Jiang *et al.*, 2018).

The initial focus of smart city initiatives investigated by the OECD related to the usage of digital information and communication technologies to improve the efficiency of urban services planning and delivery. Later, the debate started to include the effects of smart city initiatives on residents, the environment, and the local development model (OECD, 2020). The smart city definition in the European Union introduced by the European Commission accentuates their higher efficiency of leveraging traditional networks and services through the usage of digital and telecommunication technologies for the benefit of residents and businesses (European Commission, 2014).

The concept of the smart city is a continuously evolving subject of debate and a smart organisation in the public sector as defined in this article can contribute to it, especially within the context of the organisational purpose of a smart organisation over technology, orientation on educated and informed decision-making, dynamisation of local development processes, and an increase in local competitiveness and attractiveness for its development stakeholders. Smart organisations in the public sector in the context of their measurement approaches refer to smart city measurement methods defined within the subject matter literature.

The approach introduced by the Centre of Regional Science, Vienna University of Technology, (2007) is based on a set of 74 statistical indicators clustered in six areas including smart economy, smart people, smart governance, smart mobility, smart environment, and smart living. Another smart organisation measurement method is based on original indicators consisting of statistical sub-indicators in the domains of economy, human capital, governance, mobility, environment, and quality of life (Szczech-Pietkiewicz, 2015).

The CITYkeys framework developed by the European Commission (2016) focuses on smart organisation measurement through data categories of people, planet, prosperity, governance, and promotion. It contains output indicators (*e.g.*, the number of open data sets) and impact indicators (*e.g.*, reduced energy consumption). The framework contains a set of multiple indicators, as well as details of data availability, sources, reliability, and accessibility. The CITYkeys approach harmonises quantitative and qualitative data gathered through interviews. One of the most popular measurement approaches was developed by IMD-SUTD (International Institute for Management Development and Singapore University of

Technology and Design, 2017) in the form of the Smart City Index (SCI), which assesses the perceptions of residents of cities in a survey on issues related to two pillars, *i.e.* structures and technology applications available to them in their city (1), and existing city infrastructure (2). Each pillar is evaluated over five key areas: health and safety, mobility, activities, opportunities, and governance.

The United Nations initiative introduced a novel smart sustainable cities measurement approach 'The United for Smart Sustainable Cities (U4SSC)' (2017), which focused on a diverse set of cities' performance indicators in economy, society, and environment dimensions aimed at assessing smartness and sustainability aspects, including usage of ICT, physical infrastructure, social inclusion, and equity aspects in access to public services, quality of life, environmental and cultural needs of the population.

The most recent approaches in the measurement of smart organisations in the public sector include original indicators based on 43 public statistics sub-indicators structured with the preference ranking organisation method for enrichment evaluations (PRO METHEE method) (Ogrodnik, 2020) and the comprehensive framework of the OECD (2020). Analysis of smart organisations in public sector measurement methods indicates the growing importance of digitisation and connectivity (The Economist Group, 2022). The investigated smart cities measurement methods interconnect with the smart organisation definition elaborated earlier, although the former set of definitions is more quantitative in its approach to data format collection and does not comprise aspects typical for a smart organisation.

Smart city measurement methodologies are also the subject of scholarly discourse on their limitations and relate to a vast number of measurement indicators. A literature review of smart city indicators identified 1152 different smart city indicators (Petrova-Antonova & Ilieva, 2018).

Based on analysis of reviewed scholar and professional domain measurement approaches of intelligent organisations, smart organisations, and smart cities, a research gap in the measurement of smart organisations in the public sector was identified with a proposal to address this gap being the subject of the next parts of this article. A specific methodological gap identified relates to the lack of a method of measurement of correspondence between smart organisations and the entrepreneurship activities it enables and fosters in its environment. The link between a smart organisation in public sector organisations and the entrepreneurship it potentially enables and fosters is a key research phenomenon investigated in this article.

Why Do Enterprises Need to be Smart?

Entrepreneurship is a complex, multifaceted phenomenon, variously defined and classified in the literature, which evolves and creates new forms and types of behaviour. Entrepreneurship is an important factor in economic prosperity, influencing the level of economic development of regions and countries.

Nowadays, in thinking about the concept of entrepreneurship, great importance is given to the role of relational capital. Thus, Blundel and Lockett (2011) emphasize that entrepreneurship involves a complex pattern of social interactions that extends beyond individual entrepreneurs to incorporate teams, organizations, networks, and institutions. Evolutionary economics also draws attention to the role of relational capital in the development of entrepreneurship and emphasizes the importance of human capital, IT capital, and indirectly also scientific and research capital. Hence, according to Malerba and McKelvey (2020), entrepreneurship is a process with emergent properties, involves actors searching for opportunities and generating new knowledge, is affected by the learning, technological and knowledge context, involves the co-evolution of knowledge, firms, industrial structure and institutions. Using the conceptual framework of Malerba and McKelvey, a study was conducted to consider the implications of IT, human, scientific-research, and relational capital for entrepreneurship, which are contemporary conditions for the development of entrepreneurship. At the same time, it is worth noting that these conditions were the main resources (potentials) necessary for the development of smart organizations in the region, which was shown in the previous part of the article.

The development of entrepreneurship is influenced by many internal and external factors. External factors include the broad economic environment, the globalization process, and related scientific and technological progress, including advancing digitalization. This environment is changing in a turbulent and rapid manner (VUCA world), and in recent years the dynamics of these changes have accelerated, leading to an increase in risks and uncertainties both in starting new enterprises

and in running a business. Current experiences, such as the coronavirus pandemic, the war in Ukraine, rising inflation, and the climate and energy crisis increase uncertainty and make it necessary to overcome obstacles to business survival and development. It is believed that the uncertainty of the environment, resulting among other factors from the Covid-19 pandemic, has enabled a better understanding of the importance of the ability of various organizations, including enterprises, to keep up with digital innovation and the need to change business models to survive in the market (Coskun-Setirek & Tanrikulu, 2021).

There are many studies in the literature that analyse the impact of IT capital on entrepreneurship, *e.g.*, in the context of the need to move from conventional ways of working to more digitised methods to increase the chances of market success and achieve a higher efficiency level (Dima, 2021; Haaker *et al*., 2021). Digital technologies promote entrepreneurship because, firstly, digitalisation changes entrepreneurship and the process of creating new economic entities, and secondly, digital technological innovations create new entrepreneurial opportunities. Moreover, digital technologies contribute to the creation of new businesses in the digital industry (Sahut *et al*., 2021). The use of digital technologies makes it possible to increase efficiency (*e.g.*, by reducing costs, saving time, reducing downtime, training employees) and create new business models (*e.g.*, platform-based Airbnb, Uber, skill share, prosumption, etc.) (Strømmen-Bakhtiar, 2019; Ibarra *et al.*, 2018).

In light of the literature, entrepreneurship is often defined as the process of identifying, evaluating and exploiting entrepreneurial opportunities (Schumpeter, 1934; Shane & Venkatraman, 2000; Shane 2003) by applying innovative solutions to create new value (Brown & Ulijn, 2004). Today, this process is strongly dependent on human capital, including the internal knowledge of entrepreneurs (prior knowledge, experience, creativity, cognitive processes, etc.) and/or the search for and acquisition of information by entrepreneurs from external sources, such as social networks (Shu *et al*., 2018). The importance of human capital in the development of entrepreneurship is also confirmed by The Timmons model of the entrepreneurial process, in which the founder, team, and resources play a key role in addition to opportunities (Spinelli & Adams, 2011). This confirms the role of human capital in creating entrepreneurial processes, while challenging changes in education – both at the higher education level and in lifelong learning – in global entrepreneurial skills. Studies conducted in China show that entrepreneurship education in universities improves the ability to start a business in the present and to engage in entrepreneurial activities in the future (Lv *et al*., 2021).

Nowadays, the important feature of development is the intellectualisation of enterprises and the degree of science intensity of the organisation, as an adaptation to the requirements of the knowledge-based economy. Intellectual competence has the potential to enhance entrepreneurship (Abosede & Onakoya 2013). Therefore, knowledge-intensive innovative entrepreneurship is defined as new innovative firms that have significant knowledge intensity in their activity, are embedded in innovation systems, and exploit innovative opportunities in diverse evolving sectors and contexts (Malerba & McKelvey, 2020). The increasing importance of knowledge in entrepreneurial activity influenced the creation of the concept of intellectual entrepreneurship, which emphasises the links between entrepreneurship, intellectualism, and academia (Johannisson *et al.*, 2011). Therefore, the issue of teaching entrepreneurship at the university level is widely analysed in the literature, as well as the role of universities in creating innovations and transferring knowledge to the economy (*e.g*., in the context of spin-off company creation, technology transfer, science parks, incubators, and university-industry relations) (Guerrero *et al*., 2016; Gubik, 2021).

In the conditions of a constantly changing environment, the functioning of a company based on relational capital and cooperation with other entities creates opportunities to achieve a sustainable competitive advantage (Corvino *et al*., 2019) which a single enterprise, especially a small or medium-sized enterprise (SME), cannot achieve. This approach is also supported by the concept of clusters (Porter, 1990). Entrepreneurship involves establishing relationships with actors that provide opportunities to transform knowledge resources into innovations (Abosede & Onakoya, 2013). Research demonstrates the significant role of relational capital in the establishment of new businesses (Hormiga *et al*., 2011). Furthermore, there exists a positive correlation between relational capital and indicators of firm resilience (Matos *et al*., 2022), innovation capacity, and efficiency of small and medium-sized

enterprises (Sulistyo, 2016). Moreover, relational capital has been linked to the innovativeness of products developed by SMEs (Dorrego *et al*., 2013). Research also shows that highly entrepreneurial small firms tend to create entrepreneurial business networks and use them effectively to achieve sustainable outcomes (Abbas *et al.*, 2019). In manufacturing companies, reliability and information exchange can positively impact the supply chain and reduce its risks (Afshar & Fazli, 2018).

In conclusion, a new definition of entrepreneurship was proposed based on literature studies. Nowadays, entrepreneurship can be defined as a complex process of social interactions between different actors that generates new knowledge and exploits the opportunities that arise in a changing environment with a VUCA character, through knowledge, learning, experience, information search, and the use of advanced technologies (including digital) in business to create new values for stakeholders and to undertake innovative activities that are created, *e.g.*, in collaboration with research and development units.

These prior empirical results allowed us to assume the following research hypotheses:

H1: Smart organization in the region is an ambiguously defined and measured concept in the literature.

H2: There is a relationship between the wealth of the regional environment of a smart organisation and the entrepreneurship level.

H3: The level of innovative entrepreneurship shows a stronger relationship with the wealth of the regional environment of a smart organization compared to entrepreneurship in general.

RESEARCH METHODOLOGY

For a review of smart organizations' definitions and measurement methods, a systematic literature review (SLR) was applied. The review process included review design, literature search in Web of Science, Scopus, and Directory of Open Access Journals databases, literature screening after elimination of duplicated and non-English language papers, and papers with no fit to the topic of smart organizations, and finally literature analysis. The literature search resulted in 656 papers identified in the period 2002-2022, 95 of which were selected for deep reading and reporting. Synthetic results of SLR were presented in the literature review and hypotheses development subchapter on smart organization definitions and measurement methods.

The study aimed to investigate the relationship between the wealth of the regional environment of a smart organization and the entrepreneurship level, using EU regions as examples. To evaluate the relationship between smart organizations in local governments and the development of entrepreneurship in European regions, eight indicators were used, each representing one of the four capitals: human, IT, research and development, and relational capital (Figure 1). The factors influencing the development of enterprises, including innovative enterprises, are complex and multifaceted, and their measurement requires the inclusion of various indicators describing the smart potential in local governments. The difficulty in measurement is translating theoretical assumptions into measurable empirical indicators that describe a particular phenomenon. The area we selected for building the model of business development potential includes regions in Europe. The choice of indicators resulted from the literature studies conducted in the previous part of the paper, which highlighted the current conditions for entrepreneurship development and was conditioned by the availability of statistical data at the regional level in the EU.

Data for 240 regions from 22 EU Member States, Norway, Serbia, Switzerland, and the United Kingdom at different NUTS levels were used for the study. The availability of data at NUTS levels varied, so the collected indicators covered 47 NUTS 1 regions and 193 NUTS 2 regions. In the EU Member States Cyprus, Estonia, Latvia, Luxembourg, and Malta, the NUTS 1 and NUTS 2 levels are identical to the national territory, so in this case, the national level was included. The selection of indicators took into account both the broad technological potential of IT and human potential, especially digital skills and human resources for the use of modern technologies in economic and social structures (Table 1).

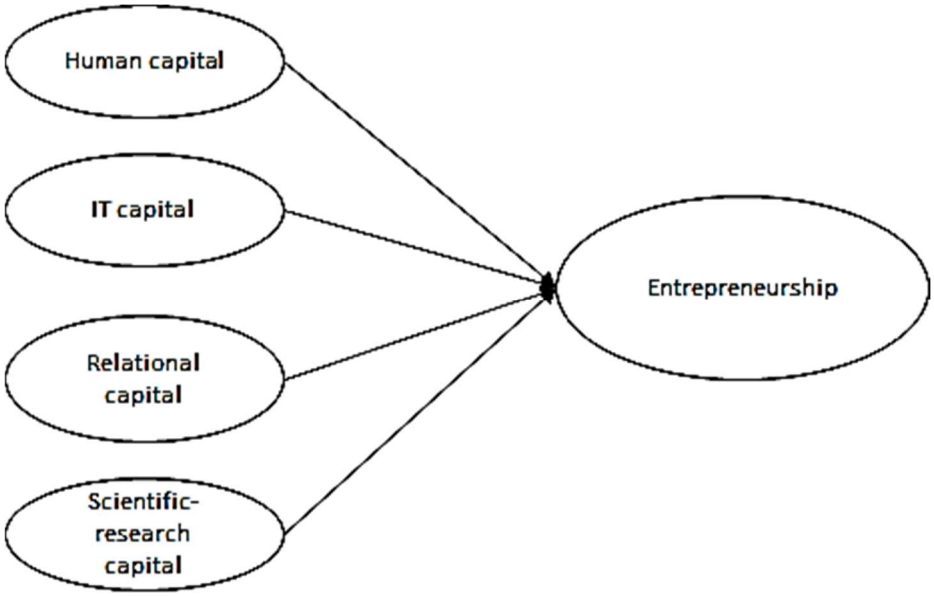

Figure 1. Resources of the regional environment of a smart organization and entrepreneurship
Source: own elaboration.

An evaluation of individual capitals was conducted to create an assessment of European regions using the standardized sums method. The selection of indicators took into account the assumptions of the concept of smart organizations and their institutional, social, and technological dimensions. The indicators were standardized and then grouped, which allowed a statistical description for each capital. Since the research aimed to identify the potentials of regions and spatial regimes, the model indicators were assigned the same weights. The process of preparing the assessment of regions for smart development included the implementation of the following activities: defining capitals; selecting empirical characteristics; standardising variables; calculating zero-sum of unitization for capitals; grouping units of the studied population by groups of capitals; evaluating the consistency of indicator structure (k-means classification).

The level of capital was evaluated by the method of linear ordering of the standardized total data. The procedure starts with standardization by normalizing the one-dimensional variables according to the following formula:

$$x_{ij}{}' = \frac{x_{ij} - x_{minj}}{x_{maxj} - x_{minj}} 100 \tag{1}$$

in which:

j - next function number,
i - next spatial unit number,
x'_{ij} - normalized feature j in the spatial unit i,
x_{ij} - the value of the feature j in the spatial unit i.

Based on the normalized variables, a vector of the normalized sums of the ratios of the individual capitals is determined. A synthetic index of the potential of a smart organization (IOP) is created as an arithmetic average of the normalized characteristics corresponding to the individual objects, where m is the number of indicators, according to the formula:

$$IOP = \frac{1}{m} \sum_{j=1}^{m} x_{ij}{}' \tag{2}$$

Table 1. Potentials (resources) of the regional environment of a smart organization used in the analysis

Capital	Indicator	Characteristic	Year	Source of data and year
Human capital	X1 Population with tertiary education	Number of people with post-secondary education aged 25-34 in relation to the total number of inhabitants aged 25-34	2019	Eurostat, regional statistics 2019
	X2 Lifelong learning	Number of people aged 25-64 in households who participated in at least four weeks of education or training in relation to the age group 25-64	2019	Eurostat, regional statistics
IT capital (digitization)	X3 Digital skills	Number of people with over basic general digital skills in the areas (information, communication, problem-solving, content creation) in relation to the age group 16-74	2019	Regional Innovation Scoreboard 2021
	X4 ICT specialists	Number of employed ICT specialists who are competent to develop, operate and maintain ICT systems and it is the main part of their work to the total number of employees	2019	Regional Innovation Scoreboard 2021
Relational capital	X5 Innovative SMEs collaborating with others	Number of SMEs operating under innovation cooperation. with other enterprises or institutions in relation to the total number of enterprises	2018	Eurostat
	X6 Public-private co-publications	Number of public-private scientific publications co-authors with both domestic and foreign collaborators in relation to the number of inhabitants	2020	Regional Innovation Scoreboard 2021
Scientific-research capital	X7 International scientific co-publications	Number of scientific publications with at least one co-author living abroad in relation to the number of inhabitants	2020	Regional Innovation Scoreboard 2021
	X8 Most-cited publications	Number of scientific publications among the 10% most cited publications in the world in relation to the number of scientific publications	2018	Regional Innovation Scoreboard 2021
Entrepreneurship	Y1 Number of business entities	Number of economic entities entered into the REGON system	2018	Eurostat
Innovative enterprise	Y2 Product process innovators	Number of small and medium-sized enterprises (SMEs) that have introduced at least one product innovation in relation to the total number of enterprises	2018	Eurostat
	Y3 Business process innovators	Number of small and medium-sized enterprises (SMEs) that have introduced at least one business process innovation that is either new to the enterprise or new to its market	2018	Eurostat

Source: own elaboration.

RESULTS AND DISCUSSION

In relation to the results of SLR performed on smart organizations definitions, a variety of propositions was identified, often overlapping with other organizational concepts such as learning organization, ambidextrous organization, and intelligent organization. Our research also allowed us to propose a well-fitting definition of a smart organization in the context of the public sector within a regional environment. This contribution extends to the theoretical development of smart organizations. In reference to methods of smart organizations measurement, a set of various approaches was identified ranging from scholar domain to professional domain approaches, including proliferating in recent years smart city concept. The identified measurement methods did not relate to enablers and emerging factors of smart organizations. We addressed the gap through a methodological contribution of the empirical research method proposed in the research methodology section.

The obtained results of the spatial distribution of the synthetic potential indicator for smart organizations can be combined with the economic regions of Europe and the level of their economic development (Figure 2). These are mainly the regions of Great Britain, Sweden, Finland, Switzerland,

the Netherlands, Germany, Sweden, and the capitals of their functional areas. These are areas of high migration activity. Residents from other regions and immigrants flock to the capital in the hope of a better job and the possibility of a higher standard of living. As a result, these cities grow very quickly and the urban space must be constantly adapted to population changes. The relatively lowest values of the indicator are found in post-communist countries, such as Poland, Romania, Bulgaria, and Hungary, as well as in Western Europe, Spain, and Portugal. These are the fastest depopulating regions in Europe, for which demographic changes pose a serious challenge. This process is the result of intra-EU migration to economically more developed regions. Moreover, there is a phenomenon of drainage, *i.e.*, the acquisition of highly qualified human capital. As a result of constant emigration, the 'sending regions' lose highly qualified people to the 'receiving regions,' which are more industrialized and economically developed. Another problem is the low fertility rate, which, coupled with the increasing average life expectancy, causes European regions to age demographically.

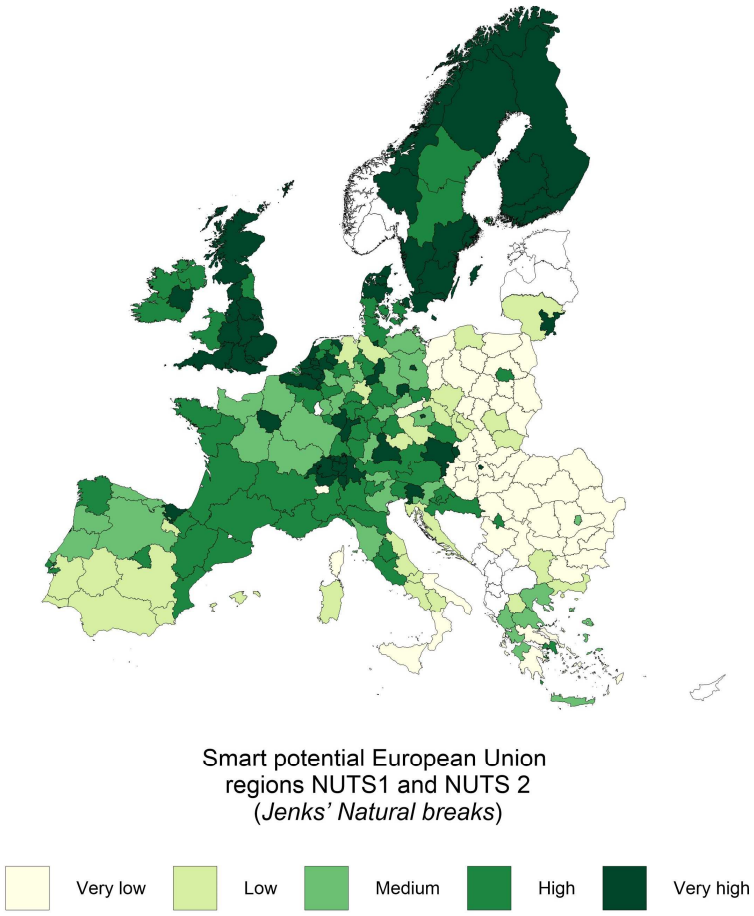

Figure 2. Smart organizations' development potential (IOP)

Note: The study used data from 240 regions from 22 EU Member States, Norway, Serbia, Switzerland and the United Kingdom at different NUTS levels. Data availability for NUTS levels varied, hence the collected indicators cover 47 NUTS level 1 regions and 193 NUTS level 2 regions. In the EU Member States, Cyprus, Estonia, Latvia, Luxembourg and Malta, the NUTS level 1 and NUTS level 2 are the same as the national territory and therefore national levels are included.
Source: own elaboration.

The developed model was used to examine the relationship between the potential of smart regions and the presence of innovative enterprises. Due to the lack of data for some countries and regions, they were excluded from the co-occurrence study. The obtained results indicate a positive correlation of the studied indicators, which means that high values of the model parameters are accompanied by high values of the dependent variables. However, in the case of potency, there are significant differences for individual indicators, which are presented below.

Table 2. Pearson's correlation matrix[1]

Variable		x1	x2	x3	x4	X5	X6	X7	X8	IOP	y1	y2	y3
1. x1	Pearson's r	–											
	p-value	–											
2. x2	Pearson's r	0.449***	–										
	p-value	1.400e-12	–										
3. x3	Pearson's r	0.393***	0.745***	–									
	p-value	9.483e-10	4.087e-41	–									
4. x4	Pearson's r	0.582***	0.462***	0.439***	–								
	p-value	8.412e-22	2.647e-13	4.905e-12	–								
5. x5	Pearson's r	0.347***	0.485***	0.592***	0.375***	–							
	p-value	8.840e-8	1.080e-14	1.227e-22	6.325e-9	–							
6. x6	Pearson's r	0.467***	0.512***	0.565***	0.638***	0.600***	–						
	p-value	1.368e-13	2.042e-16	2.093e-20	4.187e-27	2.170e-23	–						
7. x7	Pearson's r	0.547***	0.529***	0.521***	0.618***	0.578***	0.944***	–					
	p-value	6.136e-19	1.352e-17	4.580e-17	3.968e-25	1.899e-21	3.281e-109	–					
8. x8	Pearson's r	0.298***	0.560***	0.659***	0.375***	0.637***	0.665***	0.630***	–				
	p-value	5.471e-6	5.406e-20	2.151e-29	6.404e-9	5.135e-27	4.610e-30	3.007e-26	–				
9. IOP	Pearson's r	0.659***	0.768***	0.795***	0.728***	0.750***	0.866***	0.862***	0.770***	–			
	p-value	2.233e-29	4.523e-45	2.266e-50	1.977e-38	7.455e-42	3.906e-69	1.020e-67	2.541e-45	–			
10. y1	Pearson's r	0.338***	0.148*	-0.009	0.359***	0.088	0.204**	0.246***	0.171*	0.247***	–		
	p-value	2.110e-7	0.027	0.895	2.917e-8	0.191	0.002	1.961e-4	0.010	1.796e-4	–		
11. y2	Pearson's r	0.267***	0.178**	0.236***	0.624***	0.296***	0.527***	0.413***	0.217**	0.448***	0.281***	–	
	p-value	4.832e-5	0.007	3.662e-4	1.175e-25	6.386e-6	1.692e-17	1.060e-10	0.001	1.700e-12	1.917e-5	–	
12. y3	Pearson's r	0.057	0.391***	0.553***	0.296***	0.723***	0.586***	0.484***	0.595***	0.596***	0.047	0.336***	–
	p-value	0.395	1.268e-9	2.125e-19	6.318e-6	1.070e-37	4.187e-22	1.238e-14	6.014e-23	4.553e-23	0.485	2.464e-7	–

Note: [1] Regions excluded from the analysis: EL41 Voreio Aigaio, HR02 Panonska Hrvatska, HR05 Grad Zagreb, HR06 Sjeverna Hrvatska, RS11 Belgrade, RS12 Vojvodina, RS21 Šumadija and Western Serbia, RS22 Southern and Eastern Serbia, CH01 Région lémanique, CH02 Espace Mittelland, CH03 Nordwestschweiz, CH04 Zürich, CH05 Ostschweiz, CH06 Zentralschweiz, CH07 Ticino.
Significant codes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
Source: own elaboration.

The relationship between high values of potential for the development of smart organizations and the development of intelligent enterprises is noticeable. It was found that the synthetic indicator of potentials for smart IOP organizations is weakly correlated with the number of enterprises $r = 0.247$, $p < 0.001$, moderately correlated with the number of enterprises introducing product innovations $r = 0.448$, $p < 0.001$ and strongly correlated with the number of enterprises introducing business innovations $r = 0.596$, $p < 0.001$.

This confirms hypothesis H3: The level of innovative entrepreneurship shows a stronger relationship with the wealth of the regional environment of a smart organization compared to entrepreneurship in general. In the case of hypothesis H2, a strong relationship between the wealth of the regional environment of a smart organization and the level of general entrepreneurship was not confirmed.

In the case of enterprises introducing product innovations, a strong relationship was found with the X4 index – the percentage of employed ICT specialists in the total number of employees, $r = 0.624$, $p < 0.001$, and the X6 index public-private scientific publications, $r = 0.527$, $p < 0.001$ (Figure 3).

In the case of enterprises introducing business innovations, a strong relationship was found with the X3 digital skills inhabitants, $r = 0.553$, $p < 0.001$, X5 innovative SMEs collaborating with others, $r = 0.723$, $p < 0.001$, X6 public-private co-publications, $r = 0.586$, $p < 0.001$, X7 international scientific co-publications, $r = 0.484$, $p < 0.00$ and X8 most-cited publications, $r = 0.595$, $p < 0.001$ (Figure 4).

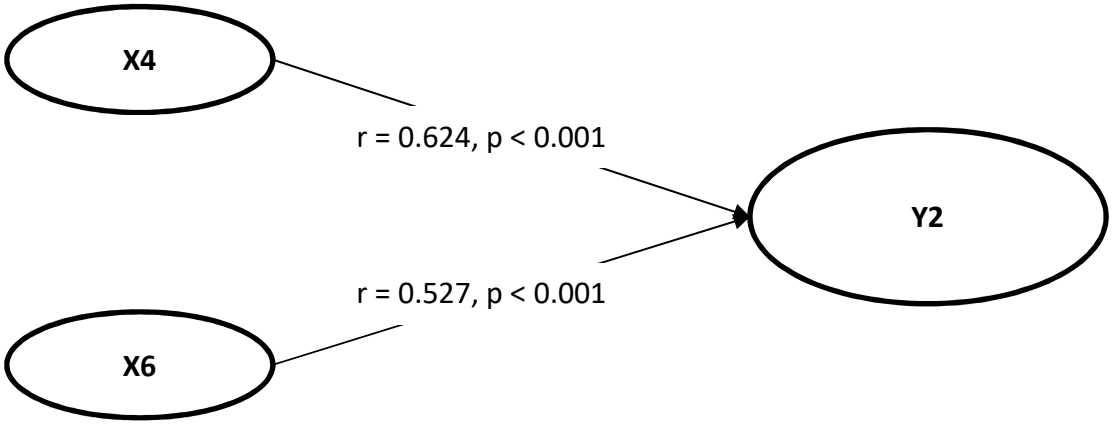

Figure 3. Model of variables for enterprises introducing product innovations
Source: own elaboration.

The obtained results can be referred to similar studies in which multivariate comparative analyses and ranking of regions were conducted. Statistical models of competitiveness have a practical dimension and a significant impact on the development of regional strategies and policies from a socio-economic perspective. An example of such a study is the EU regional competitiveness index initiated in 2010 and published by European Commission. The concept of regional competitiveness (RC) has found interest among both academics and policymakers and is a frequently cited and widely used index. It aims to measure the region's ability to offer companies and residents an attractive environment to live and work in (Dijkstra *et al.*, 2011). It is an important tool that provides a European perspective on the competitiveness of regions based on 68 indicators. The index deserves attention because of the opportunities it offers to assess and compare regions regardless of the political context. It examines the ability of regions to create growth and jobs based on three main categories of factors affecting competitiveness: economic potential, innovation, and infrastructure and business environment conditions. The latest 2023 RCI release uses a fully revised methodology and recalculated the previous two editions. RCI 2.0 consists of three sub-indicators 'basic,' 'efficiency' and 'innovation' and 11 pillars dealing with different aspects of competitiveness: 'institutions,' 'macroeconomic stability,' 'infrastructures,' 'health,' 'basic education,' 'higher education, training, and lifelong learning,' 'labour-market efficiency,' 'market size,' 'technological readiness,' 'business sophistication,' and 'innovation.' The report indicates, among other things, that the growth of innovation is crucial for improving the competitiveness of EU regions. Regions that invest in R&D and have well-developed innovative sectors tend to be more competitive (Dijkstra *et al.*, 2023).

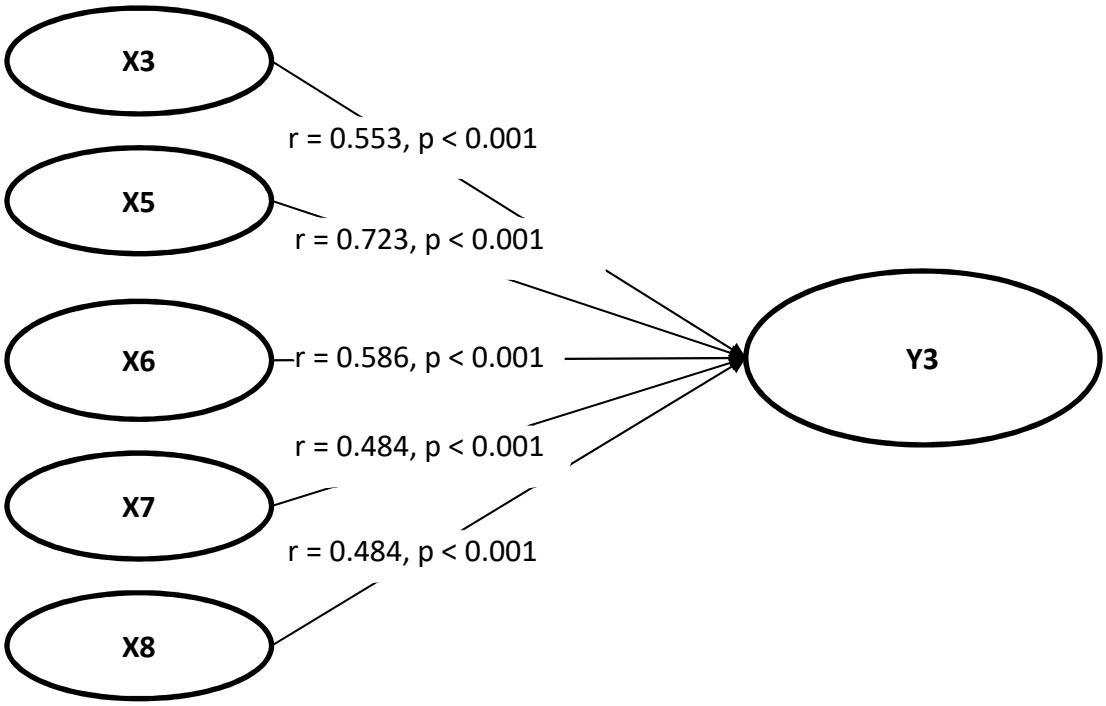

Figure 4. Model of variables for enterprises introducing business innovations
Source: own elaboration.

The second hypothesis we put forward assumed that there is a relationship between the richness of the regional environment of an intelligent organization and the level of entrepreneurship. It has been confirmed only partially, because enterprises have their specifics of functioning and not all require the involvement of new information technologies and specialized skills. Today, a large group of companies can grow despite regional deficits in digital skills and access to knowledge. These are most often sectors of the economy based mainly on traditional services and production. This group also includes enterprises and professions that, despite the development of IT technology and artificial intelligence, will not be threatened by technological substitutability shortly. These are primarily those activities in which social intelligence and high roots in social relations play a key role. Therefore, in the context of IT technology, it is currently difficult to find strong relationships between the development of entrepreneurship in general and human capital. Most European regions are in transition and the effects of the new digital revolution and economic transformation are still to come. This is also confirmed by the 2022 RCI 2.0 Competitiveness Survey of European Regions, which shows large differences in the competitiveness of European regions. The polycentric pattern prevails, with good results in regions where large urban areas are located. However, the difference between the capital city region and the other regions varies between EU Member States, with more competitive countries tending to have a smaller difference between their capital region and other regions, as well as fewer internal disparities (Dijkstra *et al.*, 2023).

On the other hand, hypothesis 3 was confirmed. It assumed that the level of innovative entrepreneurship has a stronger relationship with the richness of the regional environment of a smart organization compared to entrepreneurship in general. Innovative enterprises are more likely to demonstrate the characteristics of smart enterprises and can tap into the regional potential of IT-oriented human capital and knowledge and innovation transfer. Our research indicates that regional conditions play the greatest role in the case of business innovations, which are responsible, among other things, for organizational processes in the company and are based on human and relational capital. Interestingly, in the case of product innovations, we found a connection with only two regional factors in the form of access to IT specialists and cooperation in the field of scientific research. In the case of product innovations, joint research work conducted by private companies and public sector researchers seems

to be crucial. Our observations can be related to similar results of other studies by Malerba and McKelvey (2020), according to which IT technologies, human capital, scientific research, and relational capital are contemporary conditions for the development of entrepreneurship and the main resources (potentials) necessary for the development of smart organizations in the region. The conclusion is that the regional environment of smart organizations is a source of entrepreneurial development in the EU. This is particularly true for companies capable of absorbing and exploiting regional competitive advantages in terms of technology and knowledge.

CONCLUSIONS

The article aimed to examine the relationship between the wealth of the regional environment of a smart organization and the entrepreneurship level using EU regions as an example.

The starting point for the considerations was the classification of key terms. The identified definitions of smart organisations indicated the presence of ambiguities in the perception of the essence of this phenomenon and the development of the necessary characteristics of this type of organisation. Regardless of whether they are non-spatial or spatial, smart organisations exhibit the characteristics of learning and ambidextrous organisations. A newly-perceived aspect is the association of smart organisations with competitive advantages based on better information and knowledge management than their competitors. Moreover, smart organisations include stakeholders that both act as co-creators of these organisations and benefit from the effects of their existence. The aspect of competitiveness and the open nature of smart organisations is important for all types of smart organisations, whether they are business or spatial in nature. Therefore, we can positively confirm hypothesis H1 in the part related to the ambiguity of the definition of a smart organisation.

Thus, smart organisations are a phenomenon that is very difficult to measure. The difficulty arises both from the selection of characteristics that describe a smart organisation and from the selection of appropriate indicators that adequately describe it. There is a plethora of measurement methods proposed by scholars and practitioners, but they rarely refer to attributes that characterise smart organisations in the context of local and regional development. Therefore, we can positively confirm hypothesis H1 regarding the second part, which refers to the ambiguity of measurement methods.

We also see the need to formulate a new definition of entrepreneurship. Nowadays, entrepreneurship can be defined as a complex process of social interactions between different actors that generates new knowledge and exploits the opportunities that arise in a changing VUCA environment, through knowledge, learning, experience, information search, and the use of advanced technologies (including digital) in business to create new values for stakeholders and to undertake innovative activities that are created, *e.g.*, in collaboration with research and development units. This provides broader opportunities for interpreting research results, especially in relation to technological entrepreneurship. However, for spatial research purposes, it is necessary to limit observations to simple measures, as statistical data systems cannot keep pace with the rapidly growing digital economy. It is particularly difficult to perform such analyses in a comparable manner for regions located in different countries, even if they are members of the European Union. The problem with the availability of statistical data is the most important research limitation.

Smart organisations evolve according to changes in their external environment, new technologies and their diffusion, and the specifics of each region's path of development. Based on literature studies, it has been shown that the main resources required for the development of smart organisations in the region are IT, human, research, and relational capital, which is the answer to the second research question. The above aspects are also the current conditions for entrepreneurship development. Therefore, searching for a relationship between the wealth of the regional environment of a smart organisation and the entrepreneurship level using the EU regions as an example, we proposed measures of a synthetic nature corresponding to each regional capital and referring to the necessary characteristics of smart organisations.

Because of the application of the method of linear ordering of the standardised sum values based on data for the European regions, we can conclude that there is no evidence of a relationship between

the wealth of the regional environment of a smart organisation and the entrepreneurship level. Therefore, hypothesis H2 could not be confirmed. On the other hand, the relationship between high values of regional potential for the development of smart organisations and the development of smart enterprises is clearly evident and is the basis for confirming the validity of hypothesis H3. At the same time, it provides the basis for a deeper investigation of this relationship in relation to technological entrepreneurship or the smartification of production and services.

The reasons for this phenomenon lie in the slow process of transformation of traditional enterprises into smart and innovative ones, with the development of entrepreneurship determined by both internal and external factors. Entrepreneurship is a complex and multifaceted phenomenon and the variability of the conditions in which it operates forces it to constantly adapt and find new and competitive solutions.

Today, entrepreneurship should be characterised by the ability to innovate in uncertain times and to act intelligently in the market, recognising and taking advantage of opportunities that arise in its environment. To fulfil these functions, the company needs intelligent management resources that are different from the traditionally perceived factors of production. A new dimension in which companies are increasingly moving and conducting their activities is the digital infrastructure they use to collect and process large amounts of data. Together with the decision-making process, they create a dimension of intelligent organization, resistant or adapting to the changing environment. The relationship between the level of intelligence of a local government unit and the intensity of development of individual innovative entrepreneurship undertaken in this article is also important from the point of view of the development of location theory. Until now, the location of innovative enterprises has been explained through innovation theory and network theory, which is reflected in the concept of the triple helix as a theoretical foundation explaining the location decisions of innovative enterprises.

In the context of creating a digital economy, there is a dearth of examples illustrating how local or regional governments can create locational values that meet the new spatial needs of innovative enterprises.

New business models have a blurred spatial structure, which results from 1/ virtualization of business activity (digital products and services with supra-regional reach, digital twins, remote or hybrid work) 2/ accelerated open and at the same time network spatial structures of innovative enterprises directly from the first phase to the fifth phase of the Larry Greiner organization development cycle as a result of the spread of remote work and the development of sales platforms.

It causes the blurring of the spatial layout of companies without a clearly defined spatial structure of both the company itself and its markets. An example of this can be innovative enterprises developing on the basis of crowdfunding, prosumer behaviour, and cooperation, also based on B2B models. In view of the rapid changes in both the structures of innovative enterprises and the virtualization of public services offered by local government units, there is a need to indicate new dimensions of the location environment, important when making decisions regarding the place of registration and the place of business activity by innovative enterprises.

The research shows that regions with high development potential for intelligent organizations are a favourable environment for innovative enterprises, among which IT resources, human, research, and relational capital stand out.

The conducted research shows that today not only digital technologies, but also employees who can use these technologies in their daily work are important for companies. Fast and collective learning develops the human and organisational capital of a company. In particular, the presence of IT workers in the region and their movements in the regional labour market contribute to the development of innovative companies. In this context, smart entrepreneurship can be defined as the process of organising and conducting business activities and assuming the associated risk based on IT resources, large data sets, and computer algorithms.

In addition to the internal company factors already mentioned, the social environment is also important. Digital competencies and a high level of digital literacy are not a universal phenomenon and there are still gaps in computer and software skills in various social groups. This is a factor that can slow down the development of the digital economy, where most processes and activities are

conducted virtually through websites and various types of utilities. Digital skills also increase the chances of developing new entrepreneurship in local communities, as the Internet has expanded the unlimited possibilities of knowledge acquisition in its various dimensions. Users of new technologies can access information channels, reports, and lectures, and participate in many online meetings without having to physically move. All of this together creates new value and breaks down the barriers to accessing knowledge in entrepreneurship development.

The study also confirmed the link between the regional level of scientific research and research personnel and the development of innovative businesses. The presence of universities and research institutions in the region is a key element of innovation systems, as innovation requires collaboration, while competitive strategies do not allow entrepreneurs to fully participate in the processes of sharing sensitive strategic data that represent competitive advantages. The role of universities and research institutes is therefore to act as knowledge brokers by expanding collaboration in R&D research and developing new solutions for businesses.

These elements of the development potential of intelligent organizations are not a simple sum of accumulated elements, because of the synergy between individual components. Therefore, further research is required to identify mechanisms supporting the creation of locations of key elements of spatial structures of innovative enterprises, especially at the initial stages of innovation diffusion.

The last but very important issue to consider in the research is the growing importance of cybersecurity, the use of artificial intelligence, and related ethics and data collection and use. Digital technologies opened a new chapter in social relations by allowing us to record our behaviour and preferences and obtain sensitive data. Corporate social responsibility will therefore be responsible for how this data is used in business practice, as there is a fine line between an information society and a surveillance society. The task of new technologies, intelligent machines, and organisations is therefore sustainable development, in which quality of life is an overriding value.

Each of these research strands is a difficult research field at the regional level due to the problem with the availability of statistical data.

Creating a favourable locational environment for innovative enterprises and entrepreneurship in general requires measures to strengthen the resilience of territorial self-government units to shocks. The basis is the creation of the evolution of regions in accordance with the concept of smart city or smart village 4.0. It may also be helpful to create a basis for monitoring socio-economic development based on open databases on regions in accordance with international standards, *e.g.* ISO/CD 37123 Sustainable development in communities – Indicators for Resilient Cities.

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