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THE USE OF SOFTWARE AND IT SYSTEMS IN INNOVATIVE ENTERPRISES – THE PERSPECTIVE OF REGIONS IN POLAND

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The transformation of contemporary enterprises is a complex and multifaceted process that should be integrated into their development strategy. One of the manifestations of this transformation is the tendency of enterprises to implement and actively use specific software and IT systems, such as extranets, simple spreadsheets and text editors, relational database systems, project management software, remote desktop software, CRM systems, and Business Intelligence systems. The article's primary objective is to identify the software and IT systems used in innovative enterprises and to assess the overall complexity of this phenomenon from the perspective of Poland's regions. The basis for the analysis is the division of Poland into regions (created by voivodeships) with various levels of innovation potential. The study used a diagnostic survey. The research technique consists of CAWI interviews conducted with a random sample of 200 respondents – business owners or managers responsible for computerization/digitization processes, innovation processes, or project management employed in companies operating in Poland's most innovative sectors. The study covered the entire area of Poland (16 voivodeships). The CAWI questionnaire was based on respondents' opinions, using a 5-point scale. The study revealed that the specified regions in Poland do not differ statistically in terms of the use of specific software and IT systems. Additionally, the complexity of utilizing software and IT systems in innovation processes is moderately high. The most commonly used IT solutions include email accounts, intranets, simple spreadsheets, simple text editors, and antivirus software.

Keywords: software, IT systems, innovative enterprise, management, regions of Poland

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1. INTRODUCTION

Modern enterprises operate in a situation characterized by widespread digitization of processes (Łobejko, 2019; Vishnyakova et al., 2020; Surma, 2021; Brodny, Tutak, 2022; Knosala et al., 2024). This is related to the possibility, and in some cases, even the necessity of implementing specific software and IT[2] systems, as well as managing the IT infrastructure (Hazra, 2018, pp. 2-4; Laskowska-Rutkowska, 2024, pp. 31 et seq.). Currently available IT solutions can support the development of enterprises (including innovative ones) in various aspects of their operations, e.g., human resources, communication, logistics, manufacturing, and marketing (Oswald, Kleinemeier, 2017; Ziemba, 2018; Ziemba, Karmańska, 2021). Looking from a different perspective, it can be assumed that software and IT systems "power" decision-making processes, e.g., in the field of data acquisition, collection, processing, and analysis, or making it available to specific users (Schadt et al., 2010, p. 648 et seq.; Roffia, Dabić, 2024, p. 1354 et seq.). It should also not be overlooked that, in principle, the potential of IT solutions can determine the level of security of the so-called essential and auxiliary activities in enterprises, further affecting the broadly understood quality of innovation processes (Chudaeva et al., 2019, pp. 1-4; Yuleva-Chuchulayna, 2021, pp. 84-86).

Therefore, the article's primary objective is to identify the software and IT systems used in innovative enterprises and to assess the overall complexity of this phenomenon. The study particularly emphasizes the criterion of dividing the spatial scope of the survey (16 voivodeships) into three regions in Poland, which differ in the so-called innovative potential (measured by the share of innovatively active enterprises). The analyses aim to determine whether regions with varied innovation potential differ in the frequency of use of specific IT solutions. Therefore, the study may provide insights into how "IT-powered" innovation processes are implemented in individual regions of Poland.

The article consists of four main parts, which deal with the following issues: 1) specification of essential software and IT systems that can be implemented in innovative processes in innovative enterprises operating in Poland; 2) description of the methodological assumptions of the empirical study; 3) presentation of the main results of the study; 4) discussion and conclusions. It is also worth noting that the results, analyses, and considerations presented in the study are limited and pertain to the activities of a specific group of enterprises. Therefore, the findings should be applied primarily to the entities in the research sample, although partial generalizations may apply on a broader scale.

[2] Information Technology.

2. SOFTWARE AND IT SYSTEMS IN THE ACTIVITIES OF INNOVATIVE ENTERPRISES

Enterprises operating in a globalized environment, with widespread digitization of socio-economic processes, can leverage various IT tools to enhance their core business. IT tools can be defined as "a mechanism used to promote products and services via the Internet […]. Examples of IT tools are websites, mailings, or paid advertising in search engines" (systempartnerski.pl, 2024). It can also be assumed that "IT tools are software and systems that help plan, monitor, and control projects" (gloo.pl, 2024). Examples of essential IT tools include operating systems, application software, network management tools, and tools for automating IT processes (see Bieńkowska, Kral, Zabłocka-Kluczka, 2017; Bitkowska, Waszkiewicz, Cimoch, 2022; gloo.pl, 2024). Thus, IT tools can be defined as a broad category of software and technologies that primarily support tasks such as automation, data management, system design, and problem-solving (e.g., managerial) in the digital environment understood in the broad sense (Karasek, 2019; Choi, R'bigui, Cho, 2021). In this approach, IT tools include: programmes, applications, and platforms that primarily serve (Panduro, 2023):

– effective processing/analysis of information resources,
– improving the quality of presentation of information resources,
– improving the mechanisms of managing information resources and, consequently, entire organizations.

Macura, Kalinić and Pavić's (2022) research yields similar conclusions, indicating that IT tools facilitate quick and accurate decisions, among other benefits, by analysing large datasets, providing access to up-to-date and valuable data and information, and automating management and business processes. The authors also claim that incorrect implementation and use of IT tools can lead to wrong decisions. Therefore, the authors suggest that the optimal adjustment of IT tools should be made to the company's needs. On the other hand, Perera et al. (2022) note in their research that IT tools, particularly process automation technology, can support solving technical problems. This relieves the burden on IT staff and can enhance the overall efficiency of the organization. Ueberham, Schmidt and Schlink (2018) express a similar statement, highlighting the measurable benefits of utilizing IT tools for data integration and process automation. In their research, the authors focus primarily on improving teamwork and project work (through less organizational effort required in the IT area), which is of great importance in the case of innovative organizations, e.g., at the stage of R&D work.

At this point, it should be clearly emphasized that the implementation and use of IT tools increasingly condition the innovativeness of enterprises. These tools primarily support knowledge management and internal cooperation within the company and with external entities. In this way, it is possible to translate the functions of IT tools into company efficiency and competitiveness.

The following IT tools can be used, e.g., in the management of innovative activities (as part of innovative projects) (Shatilova, Shyshuk, 2020; gloo.pl, 2024):
- task management tools,
- tools for managing the schedule and monitoring the progress of work,
- tools for allocating and managing resources,
- communication and collaboration tools,
- document management tools.

Table 1 presents the basic and selected areas in which IT tools are applied for improving the innovative activities of modern enterprises.

Table 1. The use of IT tools in improving innovation activities – examples

IT tool type	Application area	Examples	Authors
Information Management Systems (IMS)	Project portfolio management	Efficient management of data assets/ databases/transactions.	S. Huesig and H. Endres (2019)
Communication tools	Collaboration, information exchange, and remote work	Ability to create virtual teams/ structures and operate on an international scale (open innovation model).	T.J. Marion and S.K. Fixson (2021); W. Biemans and A. Malshe (2024)
Knowledge Management Systems (KMS)	Supporting entrepreneurship, knowledge sharing	Creating knowledge repositories, gaining access to the knowledge of other entities, implementing prosumer models in the field of developing market and technological knowledge (e.g., as part of strategic alliances).	M. Del Giudice and M.R. Della Peruta (2016)
User toolkits	Personalization of products by customers or users	Possibility to submit suggestions for functions, design, etc. by users, communicating with users on an ongoing basis on social media.	E. von Hippel (2001)

Source: own elaboration using the application https://consensus.app.

As noted above, software is one of the categories included in the collection of IT tools. Modern definitions of software include both philosophical and technical aspects. Many studies emphasize the role of software as a text and interpretation process, which is particularly important in terms of improving management and inference processes, as well as innovation activities within enterprises. An engineering approach that focuses on the structure, functionality and architecture of systems is also essential. It complements the managerial and organizational aspect (tab. 2).

Table 2. Selected software definitions

Perspective	Description	Authors
Software as text and the process of interpretation	This is a hermeneutic approach. Software is defined as a form of text that must be recorded in writing and effectively executed by a machine.	L. Possati (2020)
Software as a set of semantic components	Software is defined as a set of components (e.g., methods) that can be compared at the semantic level using modern techniques such as code embeddings. This approach enables the analysis of similarities and differences between software systems, with a focus on their functionality and evolution.	S. Karakatič, A. Miloševič and T. Heričko (2022)
Software as an architectural model	Software is defined through the lens of design models and architectures, where structural properties and dependencies between system components are key.	F. Beck and S. Diehl (2010); L. Gonçales, K. Farias, T. Oliveira and M. Scholl (2019)
Software as a control and execution layer	Software is defined as a logical layer separate from the physical layer, enabling programmability and flexibility in managing network resources.	S. Kumar and S. Priya (2019); A. Shirvar and B. Goswami (2021)

Source: own elaboration using the application https://consensus.app.

Like software, IT systems are also part of a set of IT tools. An IT system can be perceived as an integrated hardware and software infrastructure, including related elements that support the achievement of the organization's goals. The key factors are interdependencies, functionality, and a systemic approach to the design and analysis of these systems (Kovačević, Groš, Đerek, 2021). In other words, an IT system is "a set of computer systems, networks and software used to process information […]. An IT system can be universal or designed for a narrow class of tasks" (Encyklopedia PWN, 2024). It is also "a collection of elements that process data using a computer" (erainformatyki.pl, 2024). The IT system includes the following components: hardware, software, human resources, database, and procedures (erainformatyki.pl, 2024). Currently, definitions of IT systems, primarily in the American and European literature, focus on the complex hardware and software infrastructure that supports an organization's functioning. Table 3 presents the basic components of the definition of IT systems.

Table 3. Components of the IT systems' definition

Component	Description	Authors
Infrastructure and components	An IT system comprises hardware and software infrastructure, including workstations, servers, laptops, installed software, databases, local area networks (LANs), firewalls, and other elements that are both physically and logically connected.	I. Kovačević, S. Groš and A. Đerek (2021)
Functions and purposes	An IT system is designed to perform specific organizational functions, primarily supporting business processes, data management, communication, and information security.	I. Kovačević, S. Groš and A. Đerek (2021)
Systems approach	An IT system is a whole, the parts of which cannot be considered in isolation, but rather as related elements that cooperate within a larger structure.	A. Backlund (2000)

Source: own elaboration using the application https://consensus.app.

The classification of IT solutions for innovative enterprises is a key "tool" for infrastructure management, which enables practical support for innovation and competitiveness of these entities on the market. In the literature, several different IT solutions are specified, which can be categorized into basic classes (fig. 1). These include both specialized software and classes of complex IT systems.

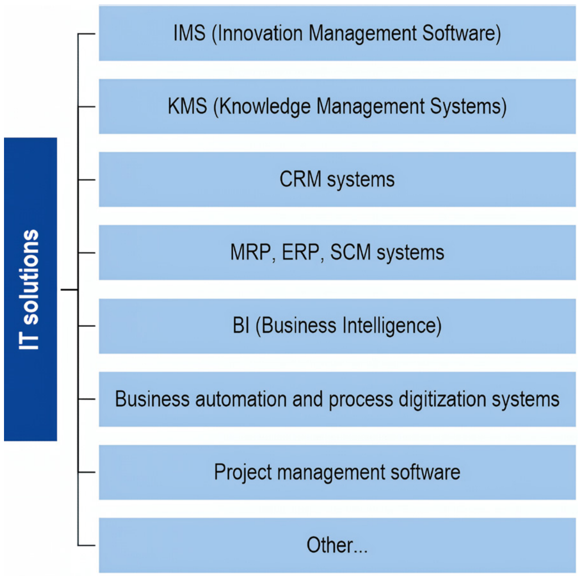

Fig. 1. Classes of IT solutions supporting the innovative activities of enterprises (own elaboration)

Developing the issue of typology of IT solutions implemented in innovative enterprises, it is worth referring to the publication by Januszewski (2012, p. 152 et seq.), and Zaskórski (2012, pp. 213-215) expose the following IT systems dedicated to innovative enterprises:
- CRM[3] class systems, i.e., multifaceted support for customer relationship management,
- WMS[4] class systems, i.e., improving warehouse space management,
- SCM[5] class systems, i.e., supporting supply chain management,
- MRP[6] and ERP[7] systems, i.e., supporting the processes of production planning, material needs, and production resources/company,
- DEM[8] class systems, i.e., systems supporting dynamic modeling/configuration of the company,
- financial and accounting systems and sales systems,
- systems that improve teamwork and project management.

The legitimacy of implementing Innovation Management Software (IMS) in innovation processes is highlighted by Endres et al. (2021). In their research, they note that this class of tools consolidates innovation programmes, stakeholders, and resources in one place. In their opinion, these solutions serve essential functions, such as ideas management, updates, and streamlining new product development processes. In other words, this class of software supports the digitization of innovation processes, increasing the efficiency of innovation development throughout its entire life cycle.

Engelstätter (2012) and Sotnyk et al. (2020) focus their research and analysis on the implementation of ERP, SCM and CRM systems. According to them, these solutions:
- increase the number of process innovations through the integration of business processes,
- support process innovation, improving supply chain management,
- increase the chances of implementing product innovations and supporting customer relationships.

Giudice and Della Peruta (2016) explore the use of Knowledge Management Systems (KMS) in innovative activities. They point out that solutions of this class enable effective knowledge management and support the development of internal innovation initiatives (intrapreneurship). They also help employees improve efficiency in business processes, which can lead to higher-quality innovation.

[3] Customer Relationship Management.
[4] Warehouse Management System.
[5] Supply Chain Management.
[6] Material Requirements Planning/Manufacturing Resource Planning.
[7] Enterprise Resource Planning.
[8] Dynamic Enterprise Modeling.

Focusing on business automation systems and process digitization, it is worth referring to the research of Sotnyk et al. (2020), who note that solutions of this type are related to implementing systems such as Business Intelligence (BI), Enterprise Resource Planning (ERP), and Industrial Internet of Things (IIoT) on digital platforms. According to the authors, this can achieve cost optimization and efficiency of innovation implementation.

It is also worth mentioning analytical systems (such as data warehouses and Business Intelligence systems), which enable and significantly improve the analysis of large data sets and increase the accuracy and effectiveness of decisions in innovative processes (Chmielarz, 2013, pp. 114-116; Surma, 2024, pp. 36 et seq.).

Nowadays, software and IT systems are a crucial management "tool" in innovative enterprises, contributing to enhancing the quality of communication and decision-making, among other things. At this point, however, it is necessary to refer to another "class" of effects of implementing software and IT systems in innovative enterprises. IT solutions have a potentially significant impact on so-called dual innovation strategies. This concerns the simultaneous implementation of exploitation innovations (improvements to existing products or processes) and exploratory innovations (the creation of new solutions). The implementation of IT solutions can strengthen both of these forms of innovation, although the effects depend on the organizational context and environment. However, as Zhao and Gao (2024) note, a high level of enterprise digitalization reinforces the positive impact of exploratory strategies on enterprise performance, while purely exploitation-oriented strategies may lose importance in an environment of advanced digitalization. Therefore, it may be a kind of "trap" for innovative enterprises.

Also crucial in this context are the findings of research by Shah et al. (2023), and Qiu and Chang (2024), which indicate that using IT has a positive impact on the implementation of both product and process innovations. According to these researchers, this should have a positive effect on the overall productivity and competitiveness of companies. In addition, according to research by Liu et al. (2024) and Zheng (2024), IT solutions can develop the dynamic capabilities of innovative enterprises. These enable a swifter response to market changes and more effective utilization of information resources to inform decisions in the innovation process.

Indicating the essence of software and IT systems, as well as the location of their basic functions within the system of innovative activities of enterprises, provides the basis for specifying the fundamental assumptions of the empirical study, i.e., the study's objectives, research problem, and research questions. These assumptions will be presented in the next part of the article.

3. METHODOLOGY

3.1. Research objective, research problem, and research questions

This study deals with the use of software and IT systems in innovative enterprises operating in Poland. The objective is to estimate the frequency and complexity of how specific software and IT systems are used in innovative processes, and to identify the differences in this regard between regions in Poland. The basis for the analysis is the division of Poland into regions (created by voivodeships) with various levels of innovation potential (the criterion of the percentage share of innovatively active enterprises was considered here). The research problem is as follows: What is the specificity of regions in Poland regarding the use of software and IT systems in innovation processes by enterprises?

The study asked the following research questions:

1) Which software and IT systems are most often used in innovation processes, in the entire sample, and the regions of Poland?
2) What is the level of complexity of using software and IT systems in innovation processes, in the entire sample, and the regions of Poland?
3) What is the percentage of innovative enterprises with moderate and high complexity of using software and IT systems in regions of Poland?
4) Do the surveyed companies from regions of Poland differ significantly regarding the frequency of use of specific software and IT systems in innovative processes?
5) Do the surveyed companies from regions of Poland differ significantly in terms of the complexity of using software and IT systems in innovative processes?

The research methods specification and the study's scope, along with a description of the research sample's structure, are presented in the next section of the article.

3.2. Research methods, scope of the study, and research sample

The study uses an inductive approach, based on individual responses/assessments of respondents (Sułkowski, 2012; Wojciechowska, 2016; Piórkowska, 2021). Analysis and synthesis methods were also used (Hajduk, 2012). The empirical method was a diagnostic survey (Karbownik, 2017). The study used the CAWI (Computer-Assisted Web Interview) survey. Statistical analysis of quantitative data was also employed (Sudoł, 2012; Zaborek, 2009). In this case, descriptive statistics were calculated, followed by principal component analysis (PCA) and cluster analysis (using the *k*-means method), as well as the Kruskal-Wallis test for independent samples. The study used an exploratory approach.

The essential research tool was the CAWI questionnaire, which contained a metric – 5 questions, the main part – 15 detailed questions requiring respondents to assess them on a 5-point scale (the value "1" meant "very rarely" and "5" – "very often") (tab. 9) and 1 screening question. PS IMAGO PRO 10.0 and MS Excel software was used.

The research referred to the CU_{IT} (Complexity of Use of Software and IT Systems) composite index. It was developed using factor analysis (principal components method) and finally took the form of a weighted average. The CU_{IT} index indicates the average frequency with which the software and IT systems included in the survey are used. The analysis employs the methodology of constructing the index mentioned above, which is based on fifteen specific measures (tab. 6). The CU_{IT} composite index was used in the study because it allows for a holistic analysis, taking into account a large number of measures and grouping them into thematically coherent components, as well as quantification and evaluation of phenomena (which are complex and challenging to quantify) (Nardo et al., 2005). To verify the quality of the data, the scale reliability analysis was performed using Cronbach's alpha coefficient (tab. 4).

Table 4. Reliability analysis – Cronbach's alpha

Cronbach's alpha	Number of Items (measures)
0.895	15

Source: own elaboration.

The methodological recommendations developed by the OECD (2008) were applied in constructing the CU_{IT} index. The adopted methodology included the following stages (Nardo et al., 2005):

- determining the scope of measurement and the legitimacy of using the composite index,
- choosing the measures, and assessing the quality of empirical data,
- assessing the relationship between the measures,
- assigning weights to components and aggregating them into a composite index.

The results of the first two stages are presented above. In assessing the relationship between the measures and the aggregation of components to the CU_{IT} composite index, the factor analysis method, specifically principal components analysis (PCA), was employed (Hudrliková, 2013). The Kaiser-Mayer-Olkin coefficient and Bartlett's sphericity test were used to verify the correctness of the PCA analysis application. The KMO coefficient was 0.888. Bartlett's sphericity test showed that the hypothesis of uncorrelated coefficients can be rejected (significance level lower than 0.001) (tab. 5). Further analysis of the PCA is justified and methodically correct.

Table 5. Kaiser-Mayer-Olkin and Bartlett tests

Tests		Value
KMO measure of sampling adequacy		0.888
Bartlett's sphericity test	Approximate chi-square	1413.192
	df	105
	Significance	<0.001

Source: own elaboration.

In further analysis, the Varimax rotation was used. Factor analysis provided the basis for classifying fifteen measures into three components. The sum of squares after rotation was approximately 62%. Assigning the measures to the components of the CU_{IT} index based on the matrix of rotated components (tab. 6) made it possible to assign weights to these components – the weights were normalized by the sums of charges' squares, which correspond to the part of the variance explained by a given component (tab. 7).

Table 6. Rotated components' matrix

Measure	Component		
	*C*1	*C*2	*C*3
*m*1 – Email accounts	–0.006	0.738	0.325
*m*2 – Social media	0.234	0.072	0.892
*m*3 – Intranet	0.280	0.527	0.127
*m*4 – Extranet	0.705	0.195	–0.104
*m*5 – Simple spreadsheets	0.216	0.841	–0.028
*m*6 – Simple text editors	0.141	0.860	–0.036
*m*7 – Relational database systems	0.587	0.462	–0.193
*m*8 – Project management software	0.764	0.172	0.124
*m*9 – Antivirus software	0.216	0.682	–0.066
*m*10 – Remote desktop software	0.561	0.306	0.137
*m*11 – Network monitoring software	0.735	0.245	0.003
*m*12 – CRM systems	0.786	0.084	0.272
*m*13 – MRP systems	0.773	0.131	0.055
*m*14 – ERP systems	0.737	0.118	0.103
*m*15 – Business Intelligence systems	0.792	0.110	0.168

Method of extracting factors – principal components. Rotation method – Varimax with Kaiser normalization. The rotation has converged in four iterations.

Source: own elaboration.

Table 7. Component weights

Component	% of variance	Cumulative %	Weight
*C*1	32.744	32.744	0.53
*C*2	21.497	54.241	0.35
*C*3	7.482	61.722	0.12

Source: own elaboration.

The formula of the CU_{IT} index (Complexity of Use of Software and IT Systems) is as follows (1):

$$CU_{IT} = 0.53C1 + 0.35C2 + 0.12C3 = \left[\frac{0.53(m4+m7+m8+m10+m11+m12+m13+m14+m15)}{9}\right] + \\ + \left[\frac{0.35(m1+m3+m5+m6+m9)}{5}\right] + 0.12m2. \quad (1)$$

The subjective, spatial, and temporal scope of the study was determined. The research sample ($N = 200$) includes large enterprises (i.e., employing at least 250 employees) operating in the most innovative sectors in Poland – entities whose representatives answered "yes" to the screening question: Have you successfully implemented at least ten innovations (in the form of a service, product, or project) for your customers in the last 5 years of your activity on the market? The selection of sectors was made based on statistics published in the reports of the Polish Development Fund (Kolasa, 2021, p. 27; Kolasa, 2024, pp. 11-14, 36). Proportional sampling in layers was employed in the study, where the layers were defined by the numbering of PKD[9] divisions of innovative enterprises (Rószkiewicz, 2021, pp. 24-26). Respondents are business owners or managers responsible for computerization/digitization processes, innovation processes, or project management (one respondent from each enterprise was included in the survey). Focusing on the spatial scope, it is worth noting that the study encompassed the entire territory of Poland (sixteen voivodeships). In addition, the survey was conducted in June 2024 and covered a maximum of the last five years of the innovative activity of enterprises, i.e., the period from January 2019 to December 2023. The IPC Research Institute from Wrocław participated in collecting empirical data.

The enterprises surveyed were classified into ten layers (developed using fourteen PKD divisions). The layers were as follows:

- Layer 1 – divisions no. 10 and 11 (production of food and beverages).
- Layer 2 – divisions no. 13 and 14 (production of textiles and clothing).
- Layer 3 – division no. 20 (production of chemicals and chemical products).

[9] Polish Classification of Activities.

- Layer 4 – division no. 21 (production of essential pharmaceutical substances, medicines, and other pharmaceutical products).
- Layer 5 – divisions no. 26 and 27 (production of computers, electronic and optical products, and production of electrical equipment).
- Layer 6 – division no. 29 (production of motor vehicles, trailers, and semi-trailers, excluding motorcycles).
- Layer 7 – division no. 52 (warehousing and service activities supporting transport).
- Layer 8 – division no. 59 (activities related to producing films, video recordings, television programs, sound, and music recordings).
- Layer 9 – divisions no. 61 and 62 (ICT and IT tools, as well as consulting activities and related activities).
- Layer 10 – division no. 65 (insurance, reinsurance, and pension funds, excluding compulsory social insurance).

The research sample was dominated by enterprises operating on the market for more than 15 years (52.0% of responses) and entities operating for 6-10 years (20.5%), as well as declaring operations on a national (35.5%), regional (27.5%) and international (23.5%) scale. The most significant percentage of enterprises were entities with an average annual turnover in the range of PLN <3-6 million (55.0%) and PLN 6 million and more (40.0%). Focusing on the spatial distribution of the surveyed enterprises, in terms of the number of surveyed enterprises, three voivodeships dominated: Mazowieckie (20.5%), Śląskie (13.0%), and Małopolskie (10.5%).

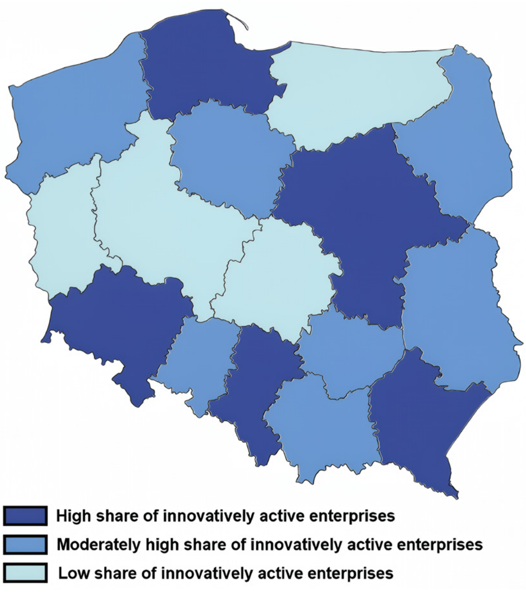

Fig. 2. Division of Poland into three regions with different shares of innovatively active enterprises (own elaboration)

When describing the structure of the research sample, reference should also be made to the specification procedure of three Polish regions with various levels of innovation potential (based on the criterion of the percentage share of innovatively active enterprises). For this purpose, reference was made to the Polish Development Fund report titled *Innowacyjność Polski. Zestawienie. Czerwiec 2024* (2024, p. 35). For each voivodeship, the values of percentage shares of innovatively active enterprises in industry and services were obtained. Based on both values, the average was calculated. In this way, three regions are specified (fig. 2; tab. 8):

– Region I – voivodeships with a high share of innovatively active enterprises (average values of share in the range: 40% and more),
– Region II – voivodeships with a moderately high share of innovatively active enterprises (average values of the share in the range: 30-39%),
– Region III – voivodeships with a low share of innovatively active enterprises (average values of the share in the range: below 30%).

Table 8. Number and percentage share of surveyed innovative enterprises in individual regions of Poland

	N	%
High share of enterprises – Region I *Voivodeships*: Mazowieckie, Pomorskie, Dolnośląskie, Podkarpackie, Śląskie	104	52.0
Moderately high share of enterprises – Region II *Voivodeships*: Kujawsko-Pomorskie, Zachodniopomorskie, Podlaskie, Lubelskie, Opolskie, Małopolskie, Świętokrzyskie	59	29.5
Low share of enterprises – Region III *Voivodeships*: Lubuskie, Łódzkie, Warmińsko-Mazurskie, Wielkopolskie	37	18.5

Source: own elaboration.

The results of an empirical study, employing the research methods and software specified above, are presented in the latter part of the paper.

4. RESEARCH RESULTS

Focusing on the issue of the frequency of use of essential software and IT systems[10] by enterprises in innovation processes, it should be noted that in both the entire research sample (N = 200) and in individual regions of Poland, the most

[10] Due to the financial constraints of the empirical study, it was necessary to consider only the basic classes/types of software and IT systems. However, the author is aware of the fact that in the literature there are more extensive lists of software and IT systems that can be used by innovative enterprises (see Zawiła-Niedźwiecki, Rostek, Gąsiorkiewicz, 2010a, 2010b, 2010c).

frequently used, in the respondents' opinion, are: e-mail accounts, intranet, simple spreadsheets, and simple text editors, as well as antivirus software. On the other hand, the least frequently used are: extranet, project management software, CRM systems, MRP systems, ERP systems, and Business Intelligence systems (tab. 9).

Table 9. The prevalence of the use of software and IT systems by enterprises

Software and IT systems	Mean			
	$N = 200$	Region I	Region II	Region III
Email accounts	4.18	4.25	4.25	3.89
Social media	3.47	3.35	3.51	3.73
Intranet	3.82	3.69	4.02	3.86
Extranet	2.91	2.86	2.95	2.97
Simple spreadsheets	4.05	4.07	4.10	3.89
Simple text editors	4.14	4.17	4.10	4.08
Relational database systems	3.62	3.48	3.85	3.62
Project management software	3.01	2.89	3.08	3.22
Antivirus software	3.91	3.84	4.02	3.92
Remote desktop software	3.27	3.14	3.42	3.35
Network monitoring software	3.07	2.92	3.08	3.46
CRM systems	2.91	2.87	2.93	3.00
MRP systems	2.90	2.79	3.02	3.03
ERP systems	2.87	2.84	2.88	2.92
Business Intelligence systems	2.76	2.57	2.83	3.19

Explanation: The darker the red colour, the lower the average rating of respondents in terms of the frequency of use of specific software and IT systems. Conversely, the darker the blue colour, the higher the average rating value.

Source: own elaboration.

The formula developed for the CU_{IT} index provided the basis for determining descriptive statistics (tab. 10). Considering the average values of software and IT system complexity, it can be noted that both in the entire research sample ($N = 200$) and in individual regions of Poland, they exceed the median value ("3") on the scale. In addition, the distribution of the index values is characterized by a weak left-tailed skewness, indicating that a slight majority of the values of this index (representing the average ratings of individual respondents) are higher than the average. The coefficient of variation is at a moderately low level (for the entire research sample at the level of 24%, and the specified regions at the level of 23% and 26% (tab. 10).

Table 10. Descriptive statistics for the value of the CU_{IT} index

Statistics	Value			
	$N = 200$	Region I	Region II	Region III
Mean	3.43	3.35	3.51	3.52
Median	3.47	3.36	3.56	3.66
Dominant	3.80	2.83*	3.06	3.05
Standard deviation	0.81	0.77	0.81	0.90
Coefficient of variation	24%	23%	23%	26%
Variance	0.66	0.60	0.66	0.82
Skewness	–0.48	–0.41	–0.63	–0.58
Kurtosis	–0.16	0.12	0.03	–0.51

* There are many modal values. The smallest value is presented.

Source: own elaboration.

Based on the above values of average ratings, it can be assumed that the level of complexity in the use of software and IT systems in innovative processes – both in the entire sample and in individual regions of Polish – is at a moderately high level (fig. 3). Of course, the division into four "intervals" used in the analysis is conventional and presents a simplified "picture" of reality. It is worth remembering that the value of the CU_{IT} index should be assessed individually in the context of the peculiarities of a given innovative company's operations.

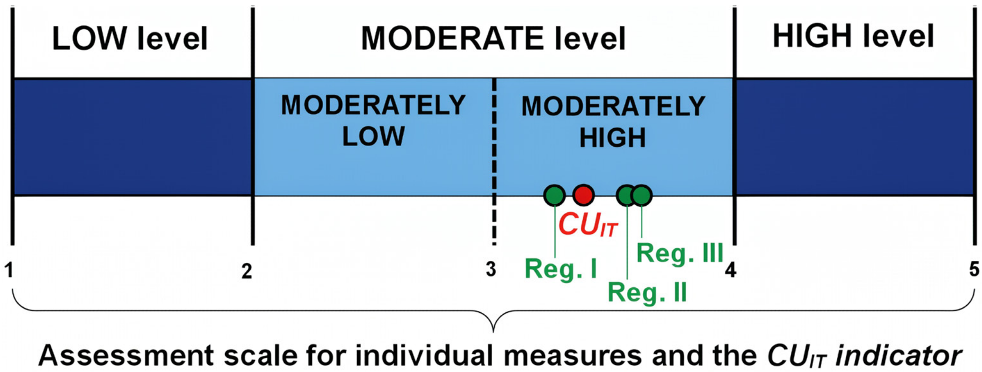

Fig. 3. Average value of the CU_{IT} index for the surveyed innovative enterprises (own elaboration)

In the above results, it is possible to refer to the percentage share of innovative enterprises with moderate and high complexity in using software and IT systems in individual regions of Poland. Using the cluster analysis (*k*-means method), three clusters of innovative enterprises, i.e., with low, moderate, and high values of CU_{IT}, were specified for each region of Poland. Region I (with a high percentage share of innovatively active enterprises) is dominated by entities with moderate and high values of the CU_{IT} index (42%) (tab. 11). On the other hand, in Region II (with a moderately high percentage share of innovatively active enterprises), innovative companies with moderate values of CU_{IT} (46%) predominate (tab. 12). In Region III (with a low percentage share of innovatively active enterprises), companies with high values of CU_{IT} dominate (43%) (tab. 13).

Table 11. Clusters of enterprises considering the value of CU_{IT} – a region of enterprises with a high share of innovatively active enterprises

	Clusters – Region I		
	Innovative enterprises with low CU_{IT} values	Innovative enterprises with moderate CU_{IT} values	Innovative enterprises with high CU_{IT} values
Stand (CU_{IT})	–1.62603	–0.36893	0.79725
$N = 104$	17 (16%)	44 (42%)	43 (42%)

Source: own elaboration.

Table 12. Clusters of enterprises considering the value of CU_{IT} – a region of enterprises with a moderately high share of innovatively active enterprises

	Clusters – Region II		
	Innovative enterprises with low CU_{IT} values	Innovative enterprises with moderate CU_{IT} values	Innovative enterprises with high CU_{IT} values
Stand (CU_{IT})	–1.60538	–0.05562	1.05437
$N = 59$	10 (17%)	27 (46%)	22 (37%)

Source: own elaboration.

Table 13. Clusters of enterprises considering the value of CU_{IT} – a region of enterprises with a low share of innovatively active enterprises

	Clusters – Region III		
	Innovative enterprises with low CU_{IT} values	Innovative enterprises with moderate CU_{IT} values	Innovative enterprises with high CU_{IT} values
Stand (CU_{IT})	–1.61791	–0.05967	1.10452
N = 37	8 (22%)	13 (35%)	16 (43%)

Source: own elaboration.

On the other hand, the Kruskal-Wallis test for independent samples was used to determine whether surveyed enterprises from individual regions of Poland differ significantly in the frequency of software and IT systems' use in innovative processes. The results (tab. 14) indicate no grounds for rejecting the H_0 hypotheses. This means that individual regions do not differ significantly in the frequency of software and IT systems' use in innovation processes.

Table 14. Kruskal-Wallis test for independent samples – the use of IT software and systems

No.	H_0	Significance[a,b]
1	The Email accounts distribution is the same for the Region category.	0.148
2	The Social media distribution is the same for the Region category.	0.279
3	The Intranet distribution is the same for the Region category.	0.392
4	The Extranet distribution is the same for the Region category.	0.888
5	The Simple spreadsheets distribution is the same for the Region category.	0.318
6	The Simple text editors distribution is the same for the Region category.	0.663
7	The Relational database systems distribution is the same for the Region category.	0.415
8	The Project management software distribution is the same for the Region category.	0.327
9	The Antivirus software distribution is the same for the Region category.	0.595
10	The Remote desktop software distribution is the same for the Region category.	0.500
11	The Network monitoring software distribution is the same for the Region category.	0.087

No.	H_0	Significance[a,b]
12	The CRM systems distribution is the same for the Region category.	0.822
13	The MRP systems distribution is the same for the Region category.	0.563
14	The ERP systems distribution is the same for the Region category.	0.924
15	The Business Intelligence systems distribution is the same for the Region category.	0.052

a. Significance level is 0.050.

b. Asymptotic significance is presented.

Source: own elaboration.

Table 15. Kruskal-Wallis test for independent samples – the complexity of using individual software and IT systems

H_0	Significance[a,b]
The CU_{IT} distribution is the same for the Region category.	0.241

a. Significance level is 0.050.

b. Asymptotic significance is presented.

Source: own elaboration.

The same test was used to assess whether companies surveyed from individual regions of Poland differ significantly in terms of the complexity of using software and IT systems in innovation processes. Additionally, there were no grounds for rejecting the H0 hypothesis in this case, indicating that individual regions do not differ significantly in the complexity of using software and IT systems in innovation processes (tab. 15).

The results presented above can serve as a basis for discussion and specification of conclusions and recommendations for managerial practice. This content will be the subject of the next part of the article.

5. DISCUSSION AND CONCLUSIONS

When analysing the results obtained, it is necessary to consider the frequency of software and IT systems' use in innovation processes. The surveyed companies are more likely to use technologically simple and, in a sense, "obvious" solutions, considering the support they provide for business and management processes. It is worth referring to email accounts, intranets, simple spreadsheets, text editors, and antivirus software. These are software that are a "standard" when it comes to equipping enterprises with IT technologies. It can also be assumed that this represents a minimum level of computerization. In principle, these solutions provide low value to both employees and external stakeholders.

However, bearing in mind that the respondents in the survey were business owners or managers responsible for computerization/digitization processes, innovative processes, or project management, employed in companies in the most innovative sectors, it should be considered whether the use of technologically advanced and modern software and IT systems in the processes of innovation must be a necessary factor for success, i.e., the development, implementation, and commercialization of innovations. The survey indicates that this is not the case.

It is also crucial that the software and IT systems rated the lowest by the respondents in terms of the frequency of their use did not achieve an average value close to "1". It proves that these solutions are not often used, but, on average, they are used in innovative processes. Therefore, some companies utilize them effectively in innovative activities, leveraging their potential. These solutions are primarily extranet, project management software, CRM, MRP, ERP, and Business Intelligence systems.

It is also interesting that, from the perspective of the entire research sample, the nominal difference between the average ratings of the frequency of use of specific software and IT systems in innovative processes is 1.42 (the highest average score is for email accounts – 4.18, and the lowest for Business Intelligence systems – 2.76). For a 5-point scale, the difference is approximately 28 pp. (tab. 9).

The fact that all the software and IT systems specified in the study are used in innovative activities – of course, bearing in mind that to a different extent and with different frequency – is confirmed by a moderately high assessment of the complexity of using these solutions (considered in the weighted average form – the CU_{IT} index), as well as a relatively large percentage share of innovative enterprises with moderate and high complexity of the use of software and IT systems in individual regions of Poland.

The study revealed that the complexity of using software and IT systems is moderate for the entire research sample and regions in Poland. At this point, however, it is crucial to focus on a particular phenomenon. Regions with a higher percentage share of innovatively active enterprises obtained lower values of the CU_{IT} index in the survey (and therefore are characterized by lower complexity of the use of software and IT systems in innovative processes) (tab. 10). However, these differences are minimal, amounting to:

- 0.16 between Regions I and II,
- 0.01 between Regions II and III,
- 0.17 between Regions I and III.

Moreover, there are no significant differences between regions regarding the frequency of use of specific software and IT systems, as well as the complexity of their use (as measured by the CU_{IT} index). Therefore, the observed "inverse" relation can be treated as "symbolic". However, it is worth monitoring this in the future to check whether this does not intensify in years to come. In addition, an "inversely proportional" relationship is visible in the case of the percentage share of innovative enterprises with moderate and high complexity in the use of software and IT systems in individual regions of Poland, e.g., in the region of enterprises with a low percentage of innovatively active enterprises, companies with high CU_{IT} values slightly dominate (tab. 13).

In summary, software and IT systems are crucial for innovative companies and are integral to their innovative processes. Nevertheless, despite the constantly developing Fourth Industrial Revolution and the trend of digital transformation of enterprises, simple, traditional and standard solutions are still used more often. It is worth emphasizing, however, that more technologically advanced software and IT systems and ones which are, in a sense, "newer" on the market are also being implemented, and their potential is used in data analysis, project management, or communication with stakeholders, for example.

An important conclusion from the study is that, regardless of the "innovation potential" of the region in Poland, software and IT systems are used with similar frequency. Therefore, it is impossible to identify regions that focus on specific IT solutions. This may be because, regardless of the share of innovatively active companies in a given region, companies observe the global environment (in which one key dimension is technological changes in the IT sector) and attempt to capitalize on the observed changes and trends. Thanks to this, regardless of the region of Poland in which the company operates, it can potentially have the same access to specific IT solutions. Therefore, for the whole of Poland, it is possible – and even recommended – to develop standardized "guides" and good practices on how to carry out the digital transformation of innovative processes. In this case, however, the following factors (which are potential "bottlenecks") should be taken into account:

- the level of development of ICT infrastructure in the region,
- habits and needs of customers in the field of communication with the use of ICT,
- the level of digital competence of the society (not only customers, but also potential employees/managers),
- the level of digital exclusion of innovative enterprises in the region and cooperating entities (e.g., entities from the public sector).

Companies engaging in innovative activities, regardless of their location in Poland, should be made aware of the potential benefits and risks associated with what is broadly understood as the digital transformation, as well as the impact this transformation has on other entities in their environment. Moreover, innovative companies require incentives to implement software and IT systems (in all regions). However, they must be aware that the peculiarity of innovation processes (taking place in their organizational system) requires an individual level and scope of digital transformation.

Further research in the computerization of innovative enterprises should focus primarily on identifying the relationship between the use of individual IT solutions and the results of innovative enterprises, e.g., in terms of:

– the efficiency of creating innovation processes,
– the efficiency of project teams,
– the durability and reliability of communication processes with stakeholders (both internal and external).

This research can also be analysed from the perspective of different regions of Poland.

At this point, it is also important to note the research limitations. Firstly, the research sample (*N* = 200) cannot be considered fully representative. Although the sample meets the requirements of representativeness in terms of size, the structure of the attributes included in the sample of innovative companies does not reflect the structure of entities in the population. Only large enterprises were also included in the survey. Thus, inference to the population should be made cautiously and with restraint. However, this does not mean that it should not take place at all. In addition, in each of the analysed regions (Region, Region II, Region III), there is a different number of enterprises, which may distort the results of comparative analyses. This therefore highlights the need to assume a certain level of error at the inference stage.

The study considered only the respondents' assessments (on a 5-point scale), which could also have distorted the actual state of the studied phenomena. While these assessments should be objective, it is challenging to eliminate subjectivity in the evaluations. With regard to research limitations, it is also necessary to note the number of variables analysed (15 variables), which was primarily due to the study's financial constraints. The CU_{IT} (Complexity of Use of Software and IT Systems) composite index developed on this basis is a simplified illustration of the use of software and IT systems in innovation processes and, in the author's opinion, its values should be treated as a general picture of the situation in innovative enterprises. To precisely determine the complexity of software and IT system usage, it is advisable to examine each company individually.

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STOSOWANIE OPROGRAMOWANIA I SYSTEMÓW IT W PRZEDSIĘBIORSTWACH INNOWACYJNYCH – PERSPEKTYWA REGIONÓW W POLSCE

Streszczenie

Transformacja współczesnych przedsiębiorstw jest działaniem złożonym i wieloaspektowym, które powinno być wpisane w strategię ich rozwoju. Jednym z przejawów wspomnianej transformacji jest skłonność przedsiębiorstw do implementacji i aktywnego stosowania określonego oprogramowania i systemów IT, np. sieci extranet, prostych arkuszy kalkulacyjnych i edytorów tekstu, systemów relacyjnych baz danych, oprogramowania do zarządzania projektami, oprogramowania do zdalnego pulpitu czy też systemów klasy CRM i Business Intelligence. Głównym celem artykułu jest wskazanie, które oprogramowanie i systemy informatyczne są wykorzystywane w innowacyjnych przedsiębiorstwach, oraz oszacowanie ogólnej złożoności tego zjawiska w perspektywie regionów Polski. Podstawą analiz jest podział Polski na regiony (tworzone przez województwa) o różnym poziomie potencjału innowacyjnego. W badaniu zastosowano metodę sondażu diagnostycznego. Technika badawcza to wywiady CAWI przeprowadzone na losowej próbie 200 respondentów – właścicieli przedsiębiorstw lub menedżerów odpowiedzialnych za procesy informatyzacji/cyfryzacji, procesy innowacyjne lub zarządzanie projektami, zatrudnionych w przedsiębiorstwach prowadzących działalność w Polsce w najbardziej innowacyjnych sektorach. Badaniem objęto całą Polskę (16 województw). W kwestionariuszu ankiety CAWI bazowano na opiniach respondentów z wykorzystaniem 5-stopniowej skali. Badanie wykazało, że wyszczególnione regiony w Polsce nie różnią się między sobą statystycznie pod kątem stosowania określonego oprogramowania i systemów IT. Ponadto złożoność wykorzystania w procesach innowacyjnych określonego oprogramowania i systemów IT jest na umiarkowanie wysokim poziomie. Najczęściej stosowanymi rozwiązaniami IT są: konta mailowe, sieć intranet, proste arkusze kalkulacyjne, proste edytory tekstu, jak również oprogramowanie antywirusowe.

Słowa kluczowe: oprogramowanie, systemy IT, przedsiębiorstwo innowacyjne, zarządzanie, regiony Polski