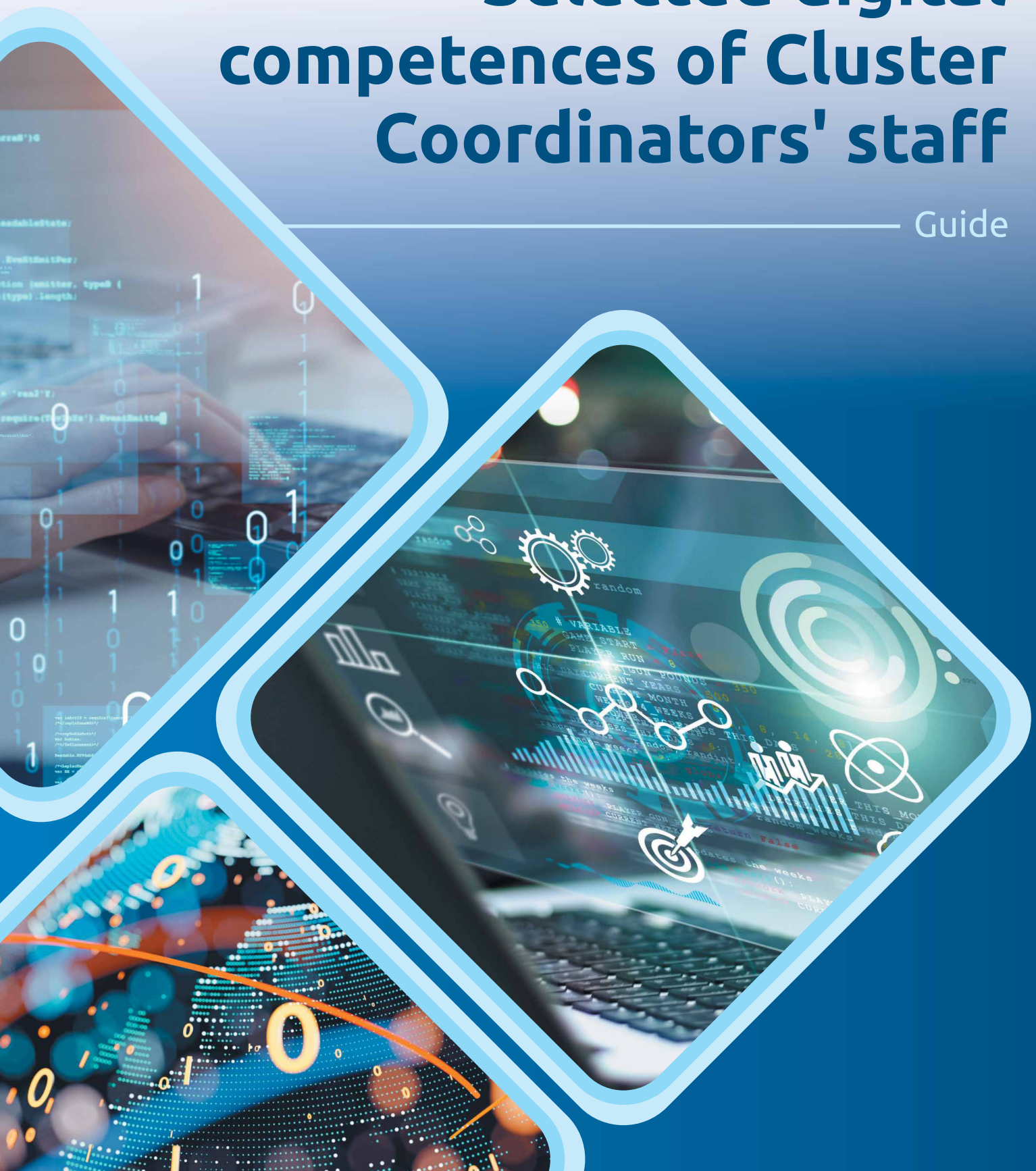
INDUSTRIE 4.0 ÖSTERREICH

Platforma Przemysłu Przyszłości

Selected digital competences of Cluster Coordinators' staff

Guide



Selected digital competences of Cluster Coordinators' staff

Guide

Selected digital competences of Cluster Coordinators' staff - Guide

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Foreword

Digitalization and Industry 4.0 are major developments affecting all businesses and industries across Europe. As regional and national networks and cluster organizations, it is our goal to support not only our members – for instance, startups, SMEs or research institutions, but also our regions and economies.

While new technology offers various benefits, dealing with it adequately can be a challenge. One way to address this challenge is through cooperation – between companies, between sectors and, as shown in this project, between countries through cross-border collaboration. Cross-border collaboration enables us to find out, how other people and organizations deal with similar issues and gives us the opportunity to learn from each other.

As the Austrian Platform Industry 4.0 we are pleased that we had the opportunity to exchange information and experiences with our Polish partners on the topic of digital competences and skills. Creating those competences and skills is of high priority in Austria and in Poland, as we could learn in this project.

Without the people with the right know-how and expertise, Industry 4.0 cannot become a reality. Therefore, we believe that this project was beneficial for both sides and we thank The Future Industry Platform for inviting us into this cooperation.

Roland Sommer,
Plattform Industrie 4.0 Österreich

Foreword

We are giving you a Guide to selected digital competences of employees of cluster coordinators' offices. This document was created as a result of cooperation between the Future Industry Platform Foundation and Verein Industrie 4.0 Österreich - die Plattform für Intelligente Produktion, a project partner from Austria, during activities financed under the Erasmus+ Programme. The guide is a joint work of experts representing the cluster environment from both countries, as well as specialists dealing with the development of digital technologies and introducing them to organizations. Its creation was preceded by a series of two workshops attended by representatives of cluster coordinators' offices, both Polish and Austrian.

As indicated by benchmarking studies carried out both in Poland and in other European countries, the current development of clusters is largely dependent on the possessed competencies affecting the possibility of carrying out digital transformation. The globalizing economy, common processes of automation and robotization of production, and the crisis caused by the COVID-19 pandemic have further accelerated the digitization processes of individual enterprises and organizations. In addition, this trend has been reinforced by striving to increase the resilience of European value chains to crisis phenomena.

A manifestation of this approach is an attempt to find new solutions based on digital technologies. The key role in this process is played by cluster coordinators who, by using their digital competences for this purpose, should contribute to the development of clusters in an orderly and methodical way, as well as be a point of reference and inspiration for their members. Currently, the coordinators of individual clusters identify a significant deficit in this respect. The key challenges in this area have been identified as competencies in: handling large data sets, programming and data visualization.

I would also like to thank the authors of the Guide and all those involved in its creation for their openness and shared knowledge. I hope that the joint effort related to the preparation of the Guide will meet with your positive interest and kind reception.

Piotr Kryjom PhD,
Deputy Director, Strategy and Development Department

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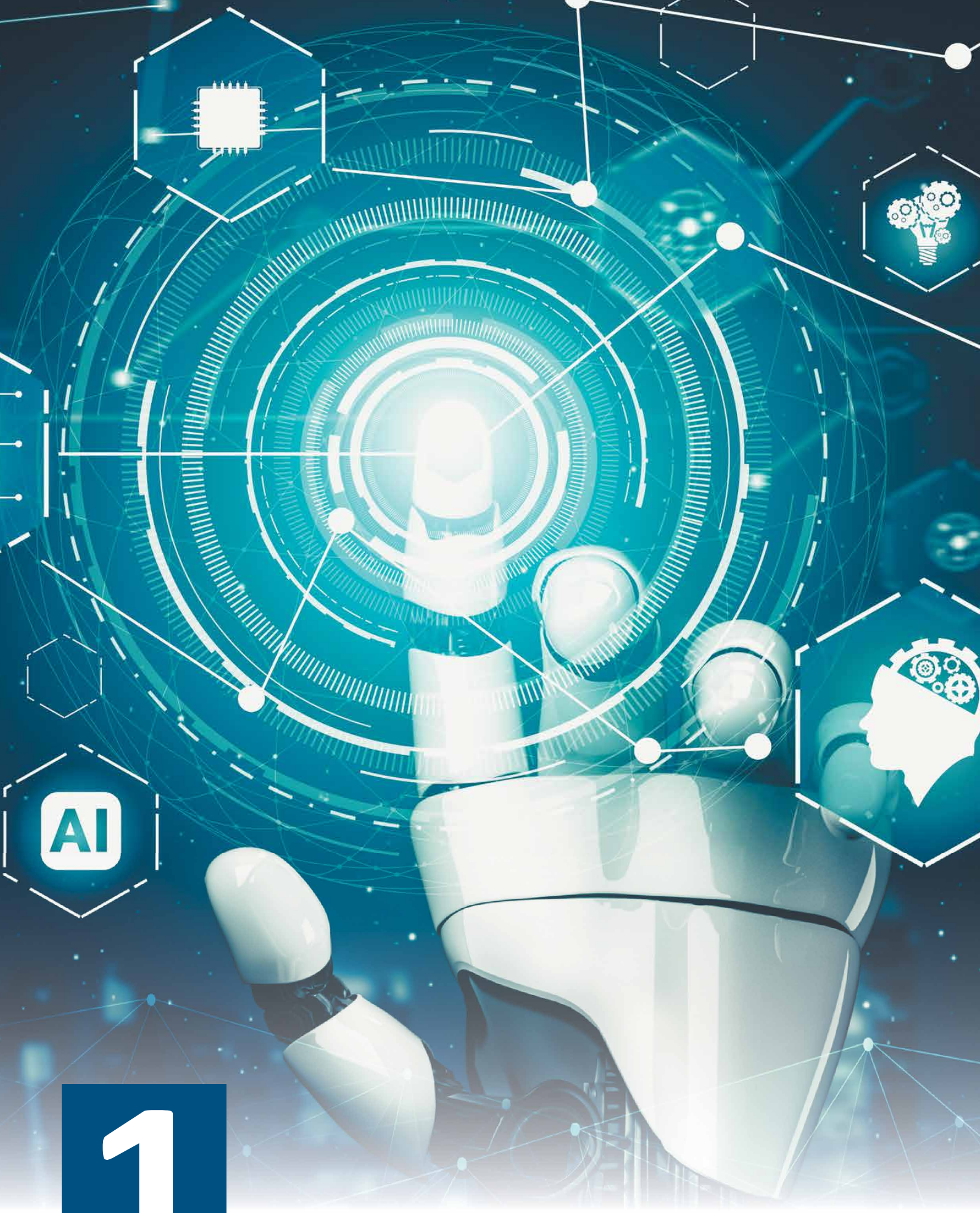


1 INTRODUCTION

1. Introduction

1.1. Digital competences as part of the digitalization of clusters

This guide is a result of project No. 2021-1-PL01-KA210-VET-000034558 "Digital competences of cluster coordinators" under implementation by the Future Industry Platform Foundation in collaboration with the Verein Industrie 4.0 Österreich – die Plattform für Intelligente Produktion, funded by the European Union under the Erasmus+ program.

The project was aimed at providing new knowledge to representatives of cluster coordinators' offices and making it possible to exchange good practices between cluster managers, both nationally and internationally. The Future Industry Platform Foundation's objective was to support the transfer of knowledge on three key technological areas related to digital transformation: **programming**, **Big Data/Data Science** and **data visualization**.

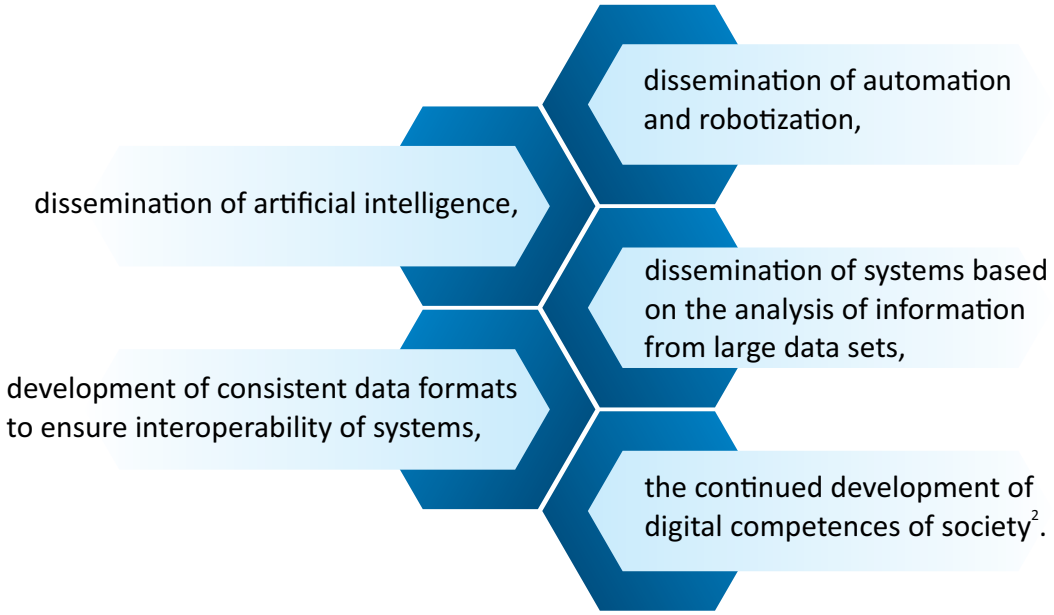
Digital transformation consists in implementing successive generations of technologies in public and private entities – companies, organizations, as well as in entire industries and sectors. In Poland, digitalization elements in the form of computerization have been present more widely since the 1990s. They are now taken for granted in office, scientific or organizational work.

However, there has been a steady dynamic development of digital technologies that are miniaturized, operate faster, have increased computing power and are subject to networking (connected to the Internet). As a result, it allows to modernize their design, both in the terms of software and hardware, and above all to use these technologies in the economy. New solutions such as 5G, Internet of Things, Data Science, Artificial Intelligence, Virtual Reality, Cloud Computing are still emerging.

At present, the changes resulting from the digital transformation are mainly manifested by a trend towards increasing the use of the indicated technologies in everyday life and striving to improve the productivity of work, and thus the competitiveness of the economy, thanks to the use of modern technologies.

This is particularly emphasized in government strategic documents – Productivity Strategy, as part of which it was assumed that digitalization and Industry 4.0 are key planes of industrial transformation in Poland[1].

In accordance with the provisions included in said document, it is necessary to prepare the economy and employees for the changes taking place by:



Source: own study.

The main objective of the strategy is to increase productivity in a low-carbon, circular and data-driven economy. As indicated in Area II (Labor and Human Capital) of the Strategy, the aspect of preparing competent employees for the digital economy is important, in particular through lifelong learning.

This is also in line with the Strategy for Responsible Development, namely its first specific objective, which is sustainable economic growth based on knowledge, data and organizational excellence. The above-mentioned objective is to be pursued through: reindustrialization, development of innovative companies, focus on small and medium-sized enterprises (hereinafter referred to as: SMEs)[3].

1 *Strategia produktywności 2030. [Productivity Strategy 2030.]* Available at: https://www.gov.pl/web/ia/strategia-produktywnosci-2030-sp2030
2 Ibidem.
3 *Strategia na rzecz Odpowiedzialnego Rozwoju do roku 2020 (z perspektywą do 2030 r.) [Strategy for Responsible Development until 2020 (with a perspective until 2030)]*. Available at: https://www.gov.pl/web/fundusze-regiony/informacje-o-strategii-na-rzecz-odpowiedzialnego-rozwoju

In this context, clusters become important as organizations bringing together companies mainly from the SME sector. Clusters are organizations that create networks of links at international and national level, introducing Polish companies into global value chains. It can therefore be concluded that clusters are an important element in the implementation of national strategic plans. This function of clusters is also demonstrated by a document of the Ministry of Development and Technology entitled "Directions of development of cluster policy in Poland after 2020", where it is recommended that: (…) *clusters can be an instrument to support the implementation of assumptions of regional smart specializations* (p. 11)[4]. Furthermore, clusters are also tools to foster knowledge transfer between the public and private sectors[5].

Scientific analyses also highlight the role of changes that are taking place. In the publication issued by the Future Industry Platform Foundation (hereinafter referred to as: FPPP) and entitled: "Gospodarka cyfrowa", Katarzyna Śledziewska and Renata Włoch pointed out that digitalization processes are no longer (…) *limited to selected sectors, certain institutions and companies, certain sectors of the state administration, accessible only to certain individuals – they are currently becoming universal* (…) *as a result, changes take place in the production and consumption models, market organization under the influence of new business models, the nature of work and employment relationships* (p. 10)[6].

Adapting to the above-mentioned trends requires improving digital competences among employees. For the purposes of public policies[7], **digital competence** is understood as a harmonious mix of knowledge, skills and attitudes enabling living, learning and working in a digital society, i.e. a society using digital technologies in work and everyday life.

The FPPP document entitled: „Poradnik dotyczący cyfryzacji łańcuchów wartości w klastrach"[8] [Guide on digitalizing value chains in clusters] highlights the important role of clusters in the

4 Mariusz Citkowski, *Kierunki rozwoju polityki klastrowej w Polsce po roku 2020* [*Directions of cluster policy development in Poland after 2020]*, Ministry of Development, Innovation Department, 2020. Available at: https://www.gov.pl/attachment/da138d48-f679-408b-b0d0-a627e2f1b593

5 Ibidem.

6 Katarzyna Śledziewska, Renata Włoch, *Gospodarka cyfrowa: jak nowe technologie zmieniają świat [The digital economy: how new technologies are changing the world],* Wydawnictwa Uniwersytetu Warszawskiego, Warsaw, 2020.

7 Katarzyna Nosalska, *Program Rozwoju Kompetencji Cyfrowych 2023-2030 [Digital Competence Development Program 2023-2030 – action lines]*, KPRM Digital Competence Development Center, 2022. Available at: https://kometa.edu.pl/pobierz/60,nosalska-katarzyna

8 Ziemowit Socha, Przemysław Wojdyła, *Uwarunkowania i metody cyfryzacji łańcuchów wartości w klastrach (raport skrócony) [Conditions and methods of digitalization of value chains in clusters (short report)]*, Future Industry Platform, 2022. Available at: https://przemyslprzyszlosci.gov.pl/uwarunkowania-i-metody-cyfryzacji-lancuchow-wartosci-w-klastrach-raport-skrocony/

economy. They support areas such as: education, promotion of business activities and economic entities, cooperation on the national and international level, research and development works and, above all, integration of associated entities and establishing new contacts with business partners. By doing so, clusters improve the competitive advantages of their members. The use of digital tools is also part of the effective creation of competitive advantages for both cluster coordinator offices and companies – cluster members.

Today's value chains, which are increasingly the result of the digital transformation, will increasingly use and analyze data to support the implementation of the measures and challenges associated with the above-mentioned areas.

The use of data can bring virtually any area of cooperation along the value chain to a higher level[9]. Big Data and artificial intelligence in particular play a very important role in digitizing processes and value chains[10]. The use of these tools offers a different view of the data collected in the chain processes and makes it possible to use more sophisticated algorithms, both statistical ones and machine learning[11]. With this in mind, it is strongly worth developing digital competences in the areas that are the focus of this guide.

1.2. Diagnosis of digital competences of cluster coordinators in Poland and Austria

In recent years, the digitalization of Polish clusters has been diagnosed at least twice: the first time as part of the periodical survey of the Polish Agency for Enterprise Development (hereinafter referred to as: PARP) entitled "Benchmarking of clusters in Poland – 2020 edition"[12] and once again by FPPP as part of a study on digitalization of value chains in clusters[13].

9 Ed. by Jana Pieriegud, Wojciech Paprocki, Jerzy Gajewski, *Cyfryzacja gospodarki i społeczeństwa - szanse i wyzwania dla sektorów infrastrukturalnych [Digitalization of the economy and society – opportunities and challenges for infrastructural sectors]*, Institute of Market Economy Research – Gdańsk Banking Academy, publication of the European Financial Congress, 2016. Available at: https://wzr.ug.edu.pl/fid/upload/files/Za%C5%82%C4%85cznik%201%20-%20Cyfryzacja%20EFC.pdf

10 For definition of the term artificial intelligence, see page 48 of the Guide.

11 For definition of the term Machine Learning, see page 48 of the Guide.

12 Maciej Piotrowski, *Benchmarking klastrów w Polsce – edycja 2020* [*Benchmarking of clusters in Poland – 2020 edition]*, Polish Agency for Enterprise Development, Warsaw, 2021, p. 70. Available at: https://www.parp.gov.pl/storage/publications/pdf/2021.06.04-Raport-oglny-PL-dostpny_13082021.pdf

13 Arkadiusz Kowalski, Anna Moskwa, Piotr Wojciechowski, Jarosław Parzuchowski, Sebastian Rynkiewicz, *Poradnik dotyczący cyfryzacji łańcuchów wartości w klastrach [Guide on digitalization of value chains in clusters]*, Future Industry Platform Foundation, 2021. Available at: https://przemyslprzyszlosci.gov.pl/poradnik-dotyczacy-cyfryzacji-lancuchow-wartosci-w-klastrach-raport-skrocony/

According to PARP findings, 23% of cluster members declared the use of digital solutions. These were mostly technological solutions such as: cloud solutions, Big Data, Internet of things, simulations, smart industrial robots, 3D printing, digital production systems[14].

In the case of FPPP surveys, on the other hand, an online survey was performed among the coordinators of National Key Clusters. The questions asked covered the level of digitalization in cluster value chains. According to the findings:

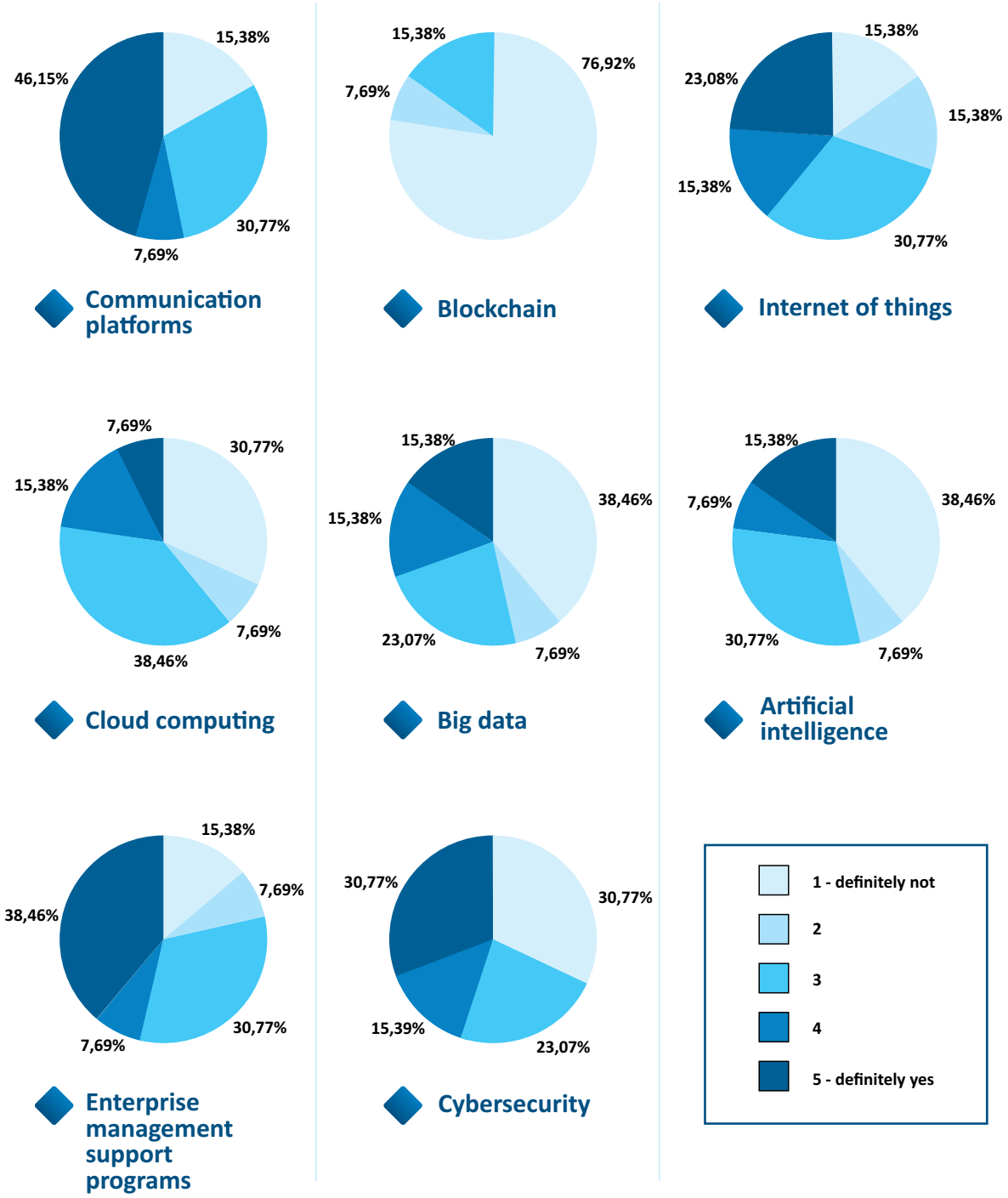
1. 50% of respondents add digital technologies to business processes currently under implementation as part of traditional industries.
2. 30% of respondents use solutions to create and process, collect, supply and make digitized content available in digital industries.
3. 10% of respondents use digital technologies to change the business model as part of a cluster value chain.
4. 10% of respondents do not use any of the above-mentioned solutions.

On the other hand, declarations on the use of communication platforms (53.84%), business management support programs (46.15%) and cyber security (46.15%) were most popular as regards the use of specific digital technologies. Blockchain (15.38%), artificial intelligence and cloud computing (23.07% each) were the least frequently indicated responses (see Diagram 1).

It can therefore be concluded that acquiring competence in Big Data/Data Science, data visualization and selected competences in programming is necessary in order to improve cluster operations. On the one hand, there is a demand for these technologies, but on the other hand they are not widely distributed in clusters. They can therefore become areas of competence development that enable clusters to play their role more effectively and enable their members to increase their competitiveness.

14 Maciej Piotrowski, *Benchmarking klastrów w Polsce – edycja 2020* [*Benchmarking of clusters in Poland – 2020 edition]*, Polish Agency for Enterprise Development, Warsaw, 2021. Available at: https://www.parp.gov.pl/storage/publications/pdf/2021.06.04-Raport-oglny-PL-dostpny_13082021.pdf

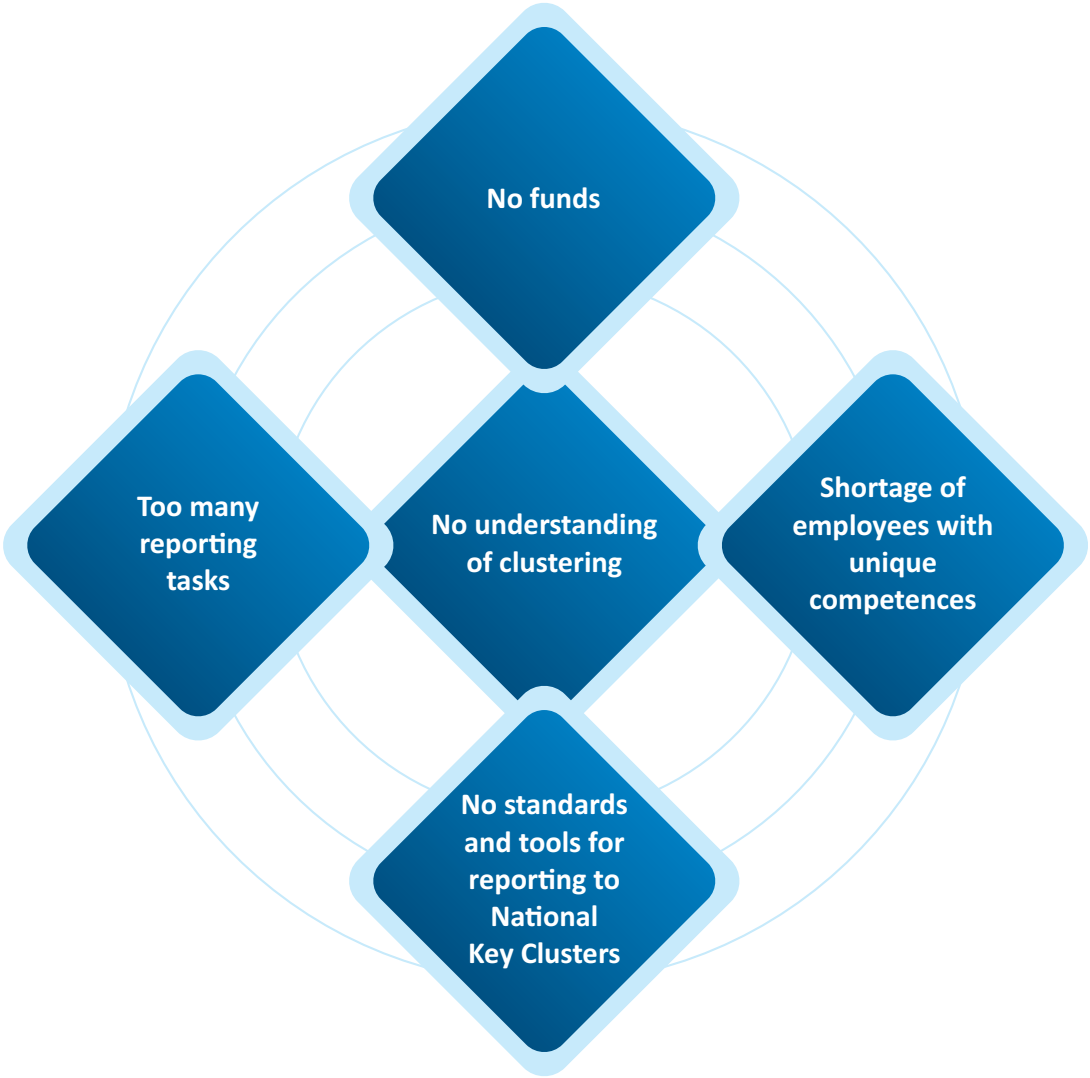
Diagram 1. Use of digital technologies by clusters



Source: Arkadiusz Kowalski, Anna Moskwa, Piotr Wojciechowski, Jarosław Parzuchowski, Sebastian Rynkiewicz, Poradnik dotyczący cyfryzacji łańcuchów wartości w klastrach [Guide on digitalization of value chains in clusters], Future Industry Platform Foundation, 2021. Available at: https://przemysl-przyszlosci.gov.pl/poradnik-dotyczacy-cyfryzacji-lancuchow-wartosci-w-klastrach-raport-skrocony/

The above diagnoses were supplemented by a four-day, twenty-hour workshop with employees of cluster coordinators, attended by both representatives of Polish and Austrian organizations. The workshop participants found (without major discrepancies) that both digital competences and the digital transformation as a whole can address the key needs of clusters as outlined in Diagram 2.

Diagram 2. Key problems of clusters



Source: own study based on workshops.

Any use of digital transformation and development of competences in this scope should be aimed at finding solutions to identified problems. Therefore, the above elements can be considered criteria for determining the needs for digitalization.

What should be also pointed out are the results of the diagnosis of the digital competences of cluster coordinators in Austria. The diagnosis is conducted by the project partner Verein Industrie 4.0 Österreich – die Plattform für Intelligente Produktion (Platform Industry 4.0 Austria – PIA). It is a non-governmental organization focusing on the digital transformation of Austrian manufacturing companies and research institutions. The objective of the PIA is to support Austrian stakeholders in developing and using digital tools and know-how.

Digital competence is an extremely important issue, often raised in Austrian political and economic discourse. An increasing number of institutions recognize that the digital competences of their staff are a key indicator of future success. This applies not only to public administrations and businesses (in various sectors of the economy), but also to intermediate bodies such as clusters.

However, it must be admitted that reality is quite different. While most cluster managers say they need to develop digital competences among their staff, they often do not yet exist in their organizations.

The reasons for this are quite different. Firstly, clusters are networks of companies. Therefore, their basic tasks are to build relations, organize networking events or communicate with members and partner organizations. For these tasks, digital competences are currently not considered necessary and are therefore not sought when recruiting new staff. There is also a very high demand for digital competences in various industrial sectors, such as IT or manufacturing. This demand faces a shortage of skilled people on the labor market, leading to high wages and attractive offers for employees with the right knowledge and skills. Clusters often have a limited budget and cannot match the wages or benefits offered by the sector. In addition, Austrian clusters rarely develop their own digital products, making it difficult for cluster managers to justify hiring people with advanced digital skills.

While deep skills such as programming or data analysis are not too common in Austrian clusters, there is at the same time quite a strong demand for lower level digital competences.

These competencies include digital communication (e.g. Slack/Teams/Zoom communication), the use of office software (e.g. MS Office, basic database skills) and the use of other digital tools (e.g. customer relationship management, content management systems). Such competences are increasingly found in Austrian clusters and are more widely available on the Austrian labor market.

1.3. Institutional partnership as a way of developing digital competences

Small-scale partnerships under Erasmus+ aim to extend access to the program to people and small operators who, for various reasons, find it difficult to reach other EU programs.

Erasmus+ projects aim to reach both less experienced organizations and all new program participants. Shorter duration and simpler administrative requirements (compared to cooperation partnerships) make it easier for organizations with fewer organizational capacities to participate in the program.

The project also aims to support flexible forms of cooperation, i.e. combining transnational and national activities. Small-scale partnerships contribute to the creation and development of international networks and to promoting synergies within local, regional, national and international policies.

The staff of the cluster coordinators' offices are suitable candidates for the development of digital competences. As mentioned in the document "Directions of cluster policy development in Poland " (Citkowski, M., *Directions...,* op. cit., p. 14), they are in constant contact with representatives of the SME sector and disseminate various information among them and can disseminate digital competences using their potential in their work. The latter is the main subject of this Guide.

Therefore, the aim of the project is to identify training needs in selected digital competences. This problem has been transferred to the European dimension, where the Future Industry Platform Foundation, in partnership with Verein Industrie 4.0 Österreich, supports the exchange of information on digital competences for Polish clusters. This action is aimed at building the FPPP's capacity for international and cross-sectoral cooperation.

In Austria, there is a high demand for employees with digital competences. While some companies and organizations have staff with existing digital competences, this may be a challenge for Austrian clusters. It is therefore important that Austrian cluster managers find ways to develop digital competences for existing employees.

However, it may be difficult for employees to acquire digital competences when working full-time in the daily activities of a cluster. Their schedule is usually filled with a large number of regular tasks – it is difficult to find time to attend academic courses or classical training courses. Alternative ways of improving the competences of cluster staff should therefore be found.

Institutional partnerships are one way to support the cluster's desire to develop digital competences. This means institutionalized cooperation on specific topics, very often financed through cooperation projects. For example, Interreg, a program funded by the European Regional Development Fund, could be a popular and effective way for cluster managers and employees to increase digital competences. Through Interreg, cluster managers can cooperate with international partners by working together on a practical project that requires digital competence. This enables learning by doing, and institutional partnership unlocks the necessary capacities. Other institutional partnerships could be Erasmus+, Digital Europe or national initiatives where cluster managers can apply for project co-financing.

The planned result of this project is to improve the quality of the work of the clusters involved. Thanks to the planned activities, participants were able to familiarize themselves with the knowledge, solutions and skills presented by Verein Industrie 4.0 Österreich›s experts in selected digital competences.

The project's method of exchanging good practices among European partners was a series of workshops. The aim was to strengthen the networking of institutions through the joint participation of cluster coordinators in expert presentations and discussions on their content. At the same time, expert contributions and discussions were moderated using digital tools, i.e. the MIRO platform.

Table 1. Topics of presentation during workshops with partners

Day 2 Programming	Day 3 Big Data/Data Science	Day 4 Data visualization
Practical Use of Programming for Clusters' Managers	Hands-On Tools To Support the Development of Data Services	Visualizations For Industrial Data Science
CODERS.BAY – at a glance	Introduction to Machine Learning Applications	Transformation of Regions, Clusters and Companies
An Engineer's Toolchain for Programming		Visualization for Industry 4.0

Source: own study.

1.4. Vision of digital competences of cluster coordinators' staff

Delivering a new type of competency for employees of cluster coordinator offices involved planning a learning process that is based on gradation logic, i.e. moves from basic to more complex issues.

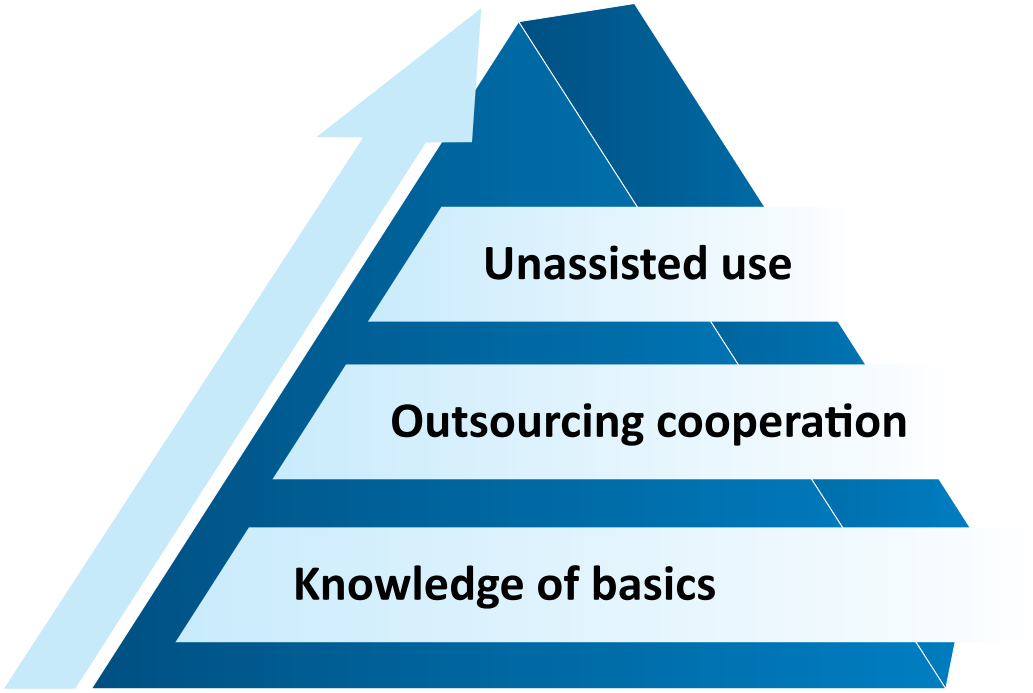
In view of the assumptions made, the development of digital competences in clusters was first outlined. The initial step is to understand the basic concepts, then to identify examples and opportunities for application and, as a result, ability to use them on their own is achieved. In accordance with this view, the path was divided into three levels within each of the described subject areas – programming, Big Data/Data Science and data visualization. The path levels are defined in detail as:

1. **Level 1 – Basic (knowledge of the basics)** – recognition of basic concepts, opportunities for using technologies and tools related to a given area of competence.
2. **Level 2 – Intermediate (outsourcing cooperation)** – knowledge of specific project implementation solutions and methods used during implementation. At this level, an employee of the cluster coordinator office has sufficient knowledge to create precise orders and communicate with IT project managers to verify the work performed.
3. **Level 3 – Advanced (unassisted use)** – skills that make it possible to modify and build simple solutions in the areas of process automation, analysis and visualization of data. This level make it possible to implement solutions using **low-code**[15] platforms or **Robotic Process Automation**[16] (RPA) or even specialized **Python** libraries.

In statistical terms, it should be noted that the basic level (knowledge of the basics) will be the most popular level of competence. The intermediate level (outsourcing cooperation) will be less popular and the advanced level (unassisted use), i.e. actually joining the IT industry, will be the least frequently achieved level of digital competences among the employees of cluster coordinator offices. This is illustrated by the diagram below.

15 For definition of the term low-code, see page 27 of the Guide.
16 For definition of the term Robotic Process Automation (RPA), see page 28 of the Guide.

Diagram 3. Grades of digital competences for cluster coordinators



Source: own study.

It should be noted that the adopted baseline model for the development of digital competences in clusters is the **ITM model**. This concept of competence development was first proposed by David Guest in 1991. Afterwards, it was promoted by Tim Brown from Ideo.

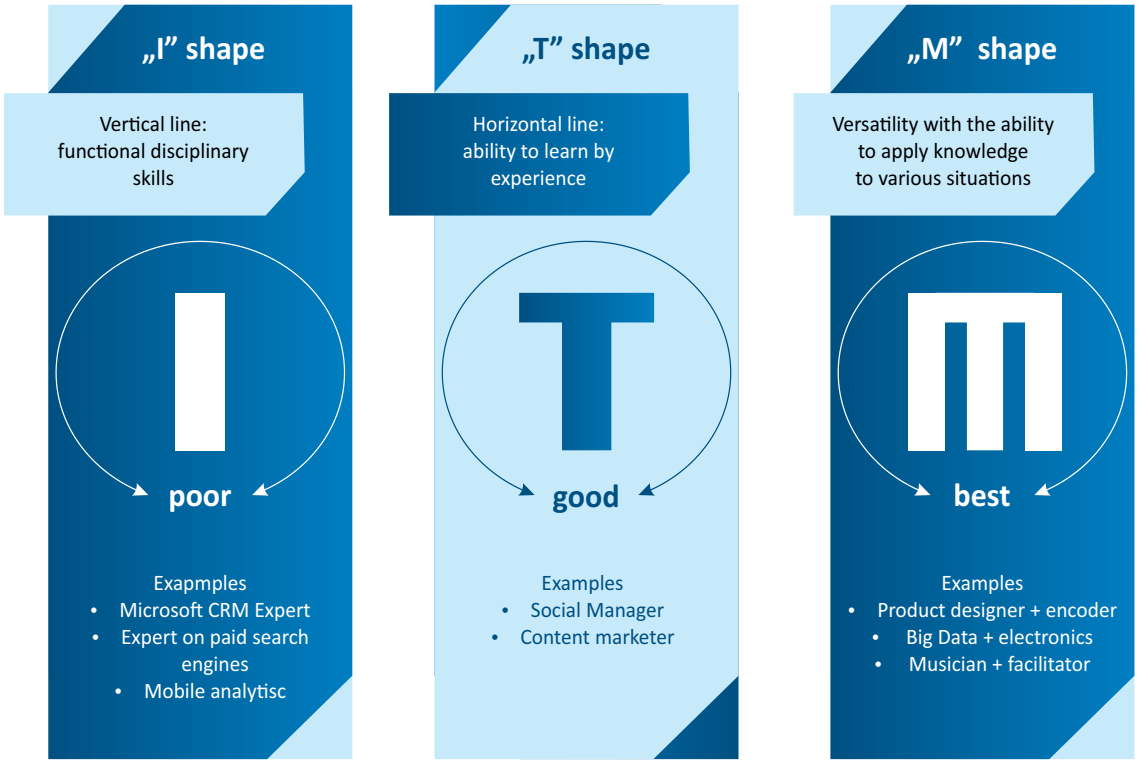
The chosen model of competencies was intended to address numerous problems resulting from too narrow scopes of specialization of IT professionals, who were additionally deprived of soft competences, which significantly hindered effective communication between teams in an organization.

In the ITM model, the competence of each individual can have two dimensions: a vertical one, i.e. degree of deepening of specialization, and a horizontal one, i.e. width of the scope of competences. The employee's standard competencies were deepened, specialized and took the form of letter I rather than letter T, i.e. deepened specialization with a wider range of soft competencies. The development of cross-cutting horizontal competences (increasing the areas of competences) results in increased professional **resilience**[17]. The objective of

17 Resilience is process of a person adapting to changing conditions, to the environment, flexibility of the mind, ability to recover lost or weakened strength and resistance to harmful factors.

such professional development, planned education and vocational training is ultimately to achieve the M model, which provides a more reliable competence base (see Diagram 4).

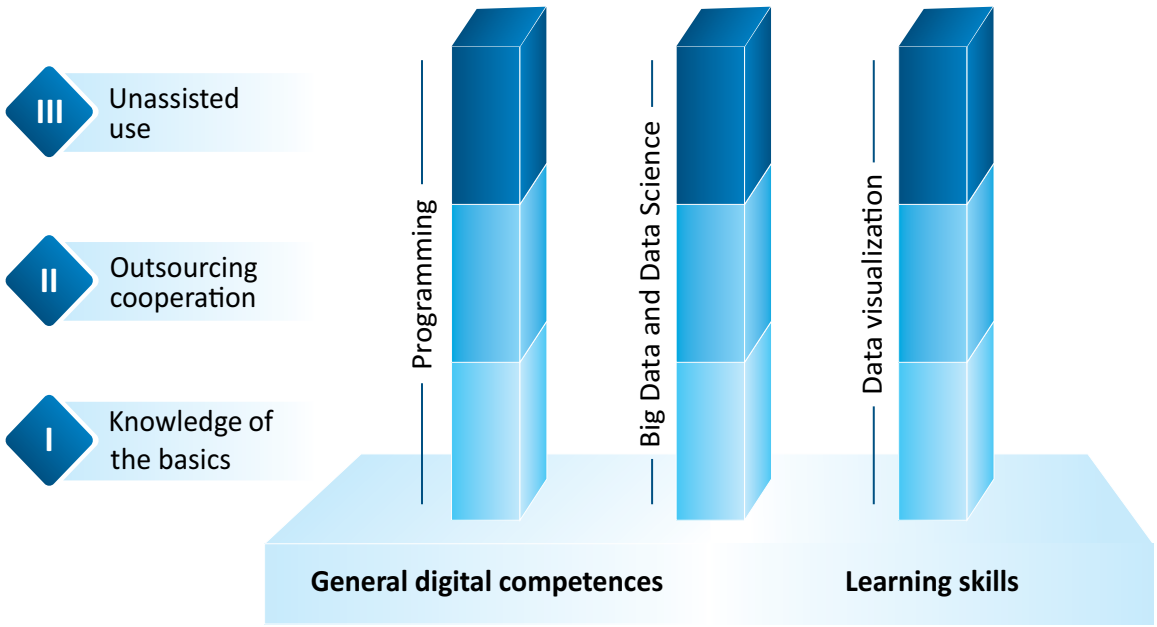
Diagram 4. Special cases of the T model of competences



Source: Own study based on https://upcity.com/blog/the-comprehensive-guide-to-hiring-a-professional-seo/

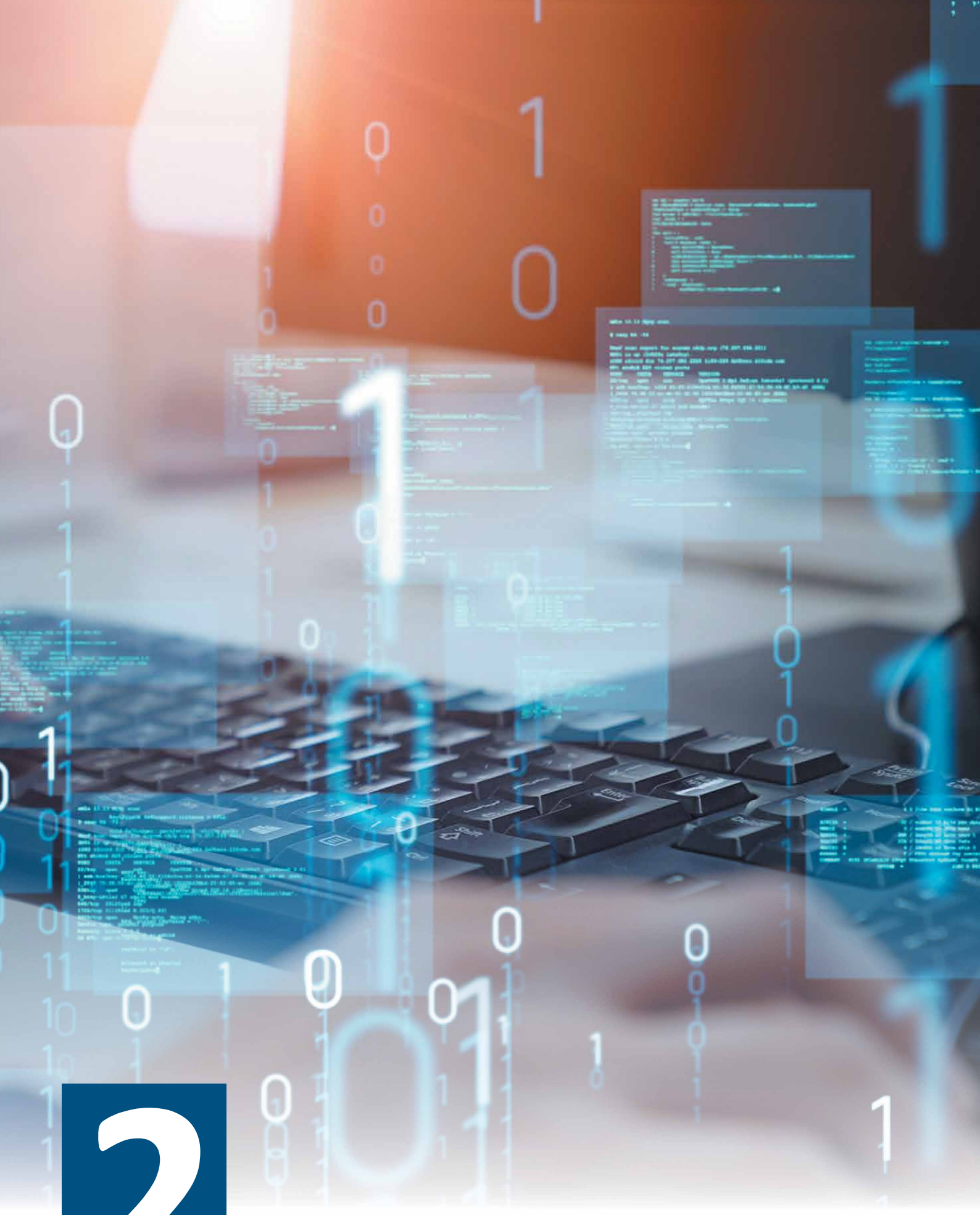
When building specialized digital competences in the work of cluster coordinator offices at the practical level, a certain reconfiguration of the logic of this model was used. In order to better illustrate the vision of building digital competences in clusters at consciously selected levels, the inverted M model can be used. Its arms will correspond to the selected digital competences and their length will be standardized in accordance with the scale of competence enhancement described above. It should be borne in mind that the vision for the development of these competences is based on general digital competences and the ability to learn (see Diagram 5).

Diagram 5. Vision of the digital competences of cluster coordinators



Source: own study.

This publication contains lessons learned from workshops attended by representatives of 10 clusters and representatives of a foreign partner, as well as material aimed at providing as concise as possible examples of technological solutions that can be implemented in cluster coordinators' offices. The document content was divided to correspond to the different parts of the workshops held by FPPP and Verein Industrie 4.0 Österreich, Austrian project partner.



2 PROGRAMMING

2. Programming

2.1. Programming competences

According to IDC and Gartner reports[18], demand for enterprise and organization applications will increase over the coming years. Businesses need applications to support business activities – from simple applications to advanced computing and business data usage systems. This is partly due to the implementation of Industry 4.0 solutions and is also the result of digitalization and digital transformation activities.

IT departments and external contractors are not able to meet these needs on their own, most often due to limited human or financial resources of contracting organizations. External subcontractors are not always the right solution. **Citizen developers**[19] are expected to help solve this problem. The concept of building specific programming skills for people who do not have technical education, let alone an industry-specific IT education, came about some decades ago. Tools supporting the process of building such solutions include, among others, **no-code/low-code platforms** (hereinafter referred to as: low-code) and **Robotic Process Automation** (RPA) tools.

2.1.1. Low-code and RPA platforms

Low-code and RPA platforms are tools for creating applications without the use of encoding or with a small amount of code, which rely, for example, on the use of ready-made, short code snippets or formulas similar to those used in an Excel sheet. Low-code platform is so-

18 *Gartner Forecasts Worldwide Low-Code Development Technologies Market to Grow 23% in 2021*, Gartner, https://www.gartner.com/en/newsroom/press-releases/2021-02-15-gartner-forecasts-worldwide-low-code-development-technologies-market-to-grow-23-percent-in-2021

19 Lucas Mearian, *Low-code tools can fill a void caused by the Great Resignation,* Computerworld, https://www.computerworld.com/article/3658908/how-low-code-tools-are-filling-a-void-caused-by-thegreat-resignation.html

ftware that makes it possible to develop applications visually, by means of diagrams, graphs or forms, without knowledge of programming languages or with basic knowledge of the commands of the selected language and several-line "programs" developed using it.

RPA, on the other hand, is designing scenarios for the operation of software robots so that they can perform repeatable, well-defined tasks that people perform on a daily basis. The best automation tasks are those that require continuous user interaction with applications and web pages. Activities that can be entrusted to software robots include, for example, moving data between applications, comparing information from different systems, searching for data on websites or servicing customers[20].

Figure 1. Low-code and RPA platforms

Source: own study.

Both solutions are used to build product, service, customer or material lists (indexes), forms (details), add records or support organization process management, such as product and inventory or purchase management. If a user can describe an application using a series of simple actions, there is a chance that you can build the application yourself with these tools. Using low-code tools, one can easily create, for example, affordable tools for conducting safety audits or defects and quality control, including reporting results in real time, visualization of these results on an interactive storage map or a production hall visible in a Power BI report.

20 Aleksandra Grendys, *Do czego w firmie można wykorzystać RPA?, [What RPA can be used for in the company?]*, Future Industry Platform Foundation, https://przemyslprzyszlosci.gov.pl/do-czego-w-firmie-mozna-wykorzystac-rpa/

Although low-code/RPA tools are mainly targeted at users with little programming and coding experience, these platforms also offer advanced functionalities. Therefore, they can also be used to design more complex applications by professional developers.

The biggest obstacle to cooperation and communication during IT projects is that business and IT simply do not speak the same language. Therefore, one of the basic approaches to designing low-code applications is **model-driven development** (MDD). The model was developed to improve collaboration and communication between business experts and developers. Its intention is to speed up the process of creating applications while increasing their usefulness and quality. In a nutshell, it starts from the data model and processes that we want to improve to better define which IT solutions are to cover the functional scope of the application.

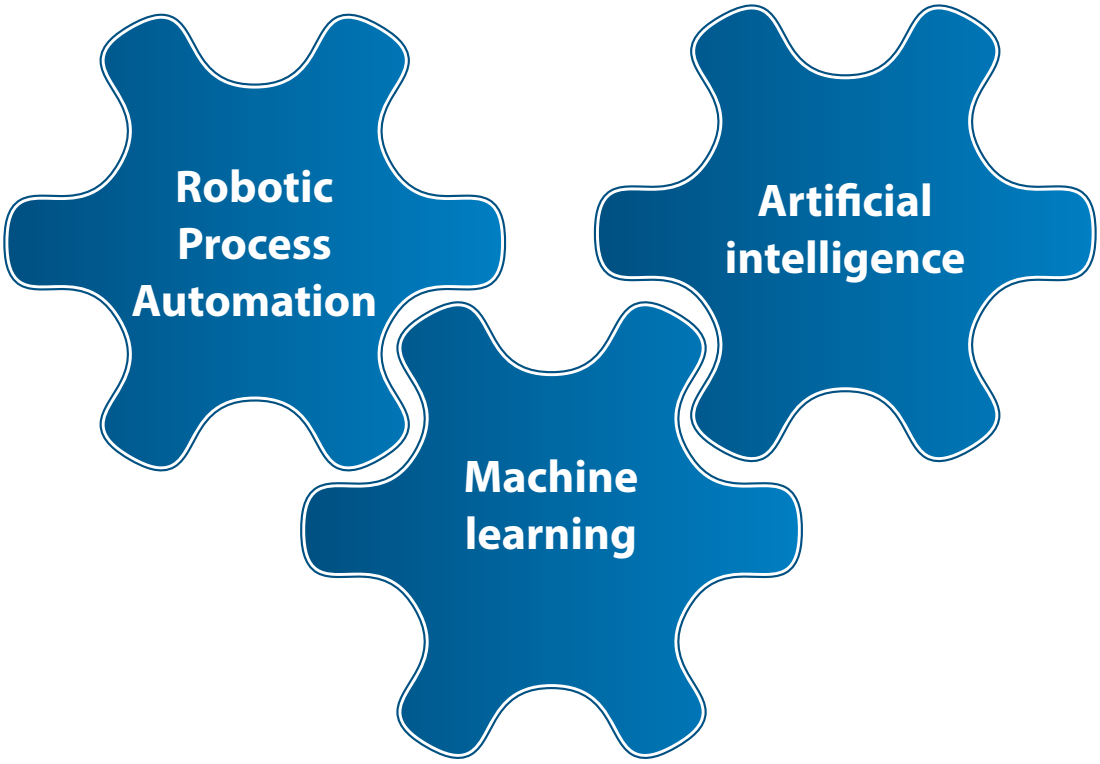
By using low-code/RPA platforms, it is possible with model-driven applications based on data models to develop a well-looking and fully functional application for processing and interacting with these data. With an application based on data model, you do not have to worry which type of application to choose – it is responsive, meaning it works on a mobile device (phone or tablet) without extra work. A platform user defines relationships, forms, views, business rules and other properties in the data layer, inside of a low-code/RPA engine. This allows you to retain sufficient control and get a business result without typing all formulas yourself.

2.1.2. Robotic Process Automation

Implementation of robotic process automation makes it possible for organizations to automate the performance of certain tasks. RPA's goal is to shift the implementation of processes from people to program robots (bots). Robotic process automation interacts with an

existing IT architecture without the need to integrate systems. RPA can also use **artificial intelligence**[21] (AI) and **machine learning**[22] (ML) to support repetitive tasks that require text processing and analysis, image recognition and classification or data learning. API is an important mechanism used in RPA class tools.

Figure 2. Robotic Process Automation



Source: own study.

Application Programming Interface (API) is one of the most important elements in the development of applications and software systems. API primarily simplifies software development and enables data exchange between applications by ensuring seamless integration. Its main functions include ensuring the possibility of reusing components and expanding the functionality of systems without the need to duplicate previously developed best practices. One example is payment gateways such as Blik, PayPal, PayU or Przelewy24. By making API available by online payment service providers, businesses do not need to implement their own payment gateways in their systems, but can use ready-made APIs to access these services.

21 For definition of the term artificial intelligence, see page 48 of the Guide.
22 For definition of the term Machine Learning, see page 48 of the Guide.

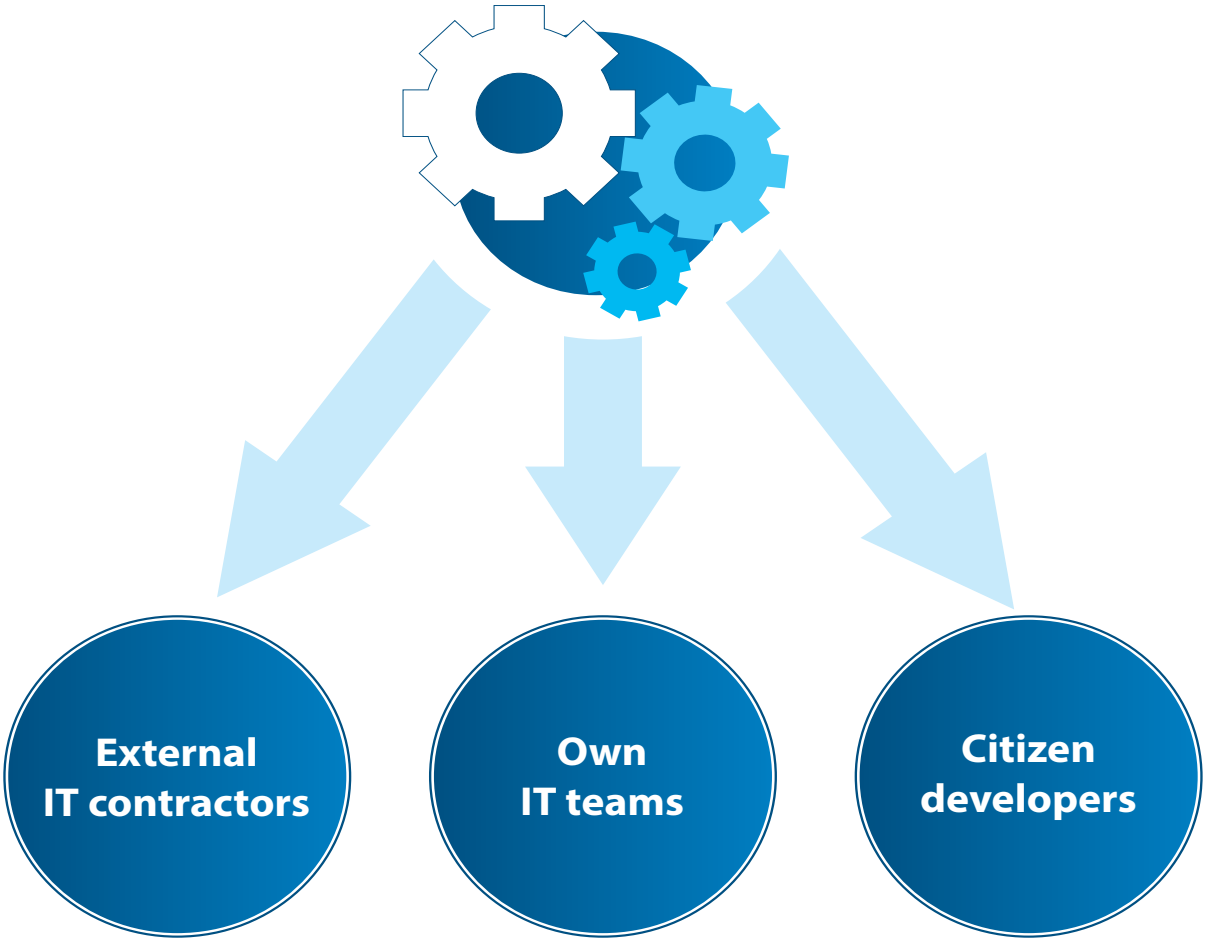
The low-code or RPA approach does not create barriers to learning programming languages, even at the intermediate (junior) level. In addition, for executives, it can encourage a better understanding of the technical aspects of the software and API lifecycle, potentially giving managers much more control and insight into the software development process.

2.2. Programming in the work of cluster coordinators

Digital transformation in companies and organizations requires new solutions of varying scale and technology level. To support the further development of digital solutions and the implementation of further innovations, cluster coordinators can perform software development tasks for their own needs and/or for the needs of cluster members in three ways:

1. **External IT contractors** – a classic approach used in the market. Due to the specificities of their activities, clusters take advantage of these opportunities in specific projects, most often with public funding.
2. **Own IT teams** – an approach known from large organizations and corporations. For obvious economic reasons, it is rarely used at the level of the cluster coordinator, where the IT team is usually limited to the collaborator.
3. **Citizen developers** – an approach in which selected persons in managerial, office, administrative positions, etc. can acquire the qualifications necessary to build simple applications using low-code/RPA platforms. Employees can acquire competencies of at least such a level as to be able to participate in the work of teams implementing applications.

Figure 3. Software development methods



Source: own study.

External IT contractors and own IT teams are a classic approach to IT tasks and projects. In view of the growing programming deficit and the high costs of building their own teams and outsourcing any work, it is most rational to use the concept of citizen developers.

From the point of view of cluster coordinators, under such assumptions, the designed competence model can be divided into three levels.

Level 1 – Basic (knowledge of basics)

These are the competences necessary to participate in the activities related to the implementation of IT projects in the organization. The basis is to gain knowledge of concepts, capabilities and principles of software application in the digitalization of business processes. All employees of cluster coordinators' offices should have knowledge at least at this level.

Table 2. Learning achievements for Cluster Coordinators. Programming – basic level

	Knowledge
1	Describes the lifecycle of an IT project.
2	Understands what the individual milestones mean.
3	Basic information on Agile/Scrum methodologies.
4	Defines the key concepts of computational thinking, i.e. at least: software, software manufacturing, testing and security; how the software works; desktop, mobile and web applications.
5	Describes the software lifecycle and production.
6	Describes IT project management areas, e.g. Prince2.
7	Defines basic concepts in business analysis, business process modeling and use of data models, i.e. at least: business process, business activity, functional requirement, analysis of requirements, coverage of requirements, canonical data model, domain model.
8	Defines key concepts from the area of data modeling, data models, data sources and their reflection in the real world, i.e. at least: tables, relationships, keys.
9	Defines key concepts from the database area, i.e. at least: database management system, database server, client-server architecture, transaction.
	Skills
1	Interprets business process models to a basic extent using basic notation knowledge (BPMN – Business Process Modeling & Notation).

Source: own study.

Level 2 – Intermediate (outsourcing cooperation)

This is a level reserved for persons who actively participate in projects. Their knowledge should be extended to include the capabilities of selected business analysis methods. With knowledge at the Intermediate level, you can participate in activities related to the preparation of IT projects for implementation and their subsequent implementation. This applies in particular to e.g. definition of requirements, pre-implementation analysis, assistance to users in solving problems, as well as joint team work with IT professionals.

Table 3. Learning achievements for Cluster Coordinators. Programming – Intermediate level

	Knowledge
1	Defines the concepts of designing data models for later analysis, e.g. defines the roles of data models in business analysis, process modeling and KPIs, defines the roles of data models in data analysis.
2	Describes the importance of using data models to determine IT integration requirements.
	Skills
1	Works using the Agile/Scrum methodology.
2	Models business processes.
3	Analyzes business processes in terms of digital transformation.
4	Uses Customer Journey Map[23] and User Stories[24] to analyze requirements.
5	Uses data models to determine IT integration requirements.

Source: own study.

Level 3 – Advanced (unassisted use)

This level describes the competences of those who would like to build low-code/RPA platforms and tools on their own. Depending on the platform and even on the specific task, the range of knowledge and skills required may vary. For example, you can build a simple web or mobile application that displays details about orders, cluster members (or records from another registry) without having to use scripting languages or API.

It is the low-code/RPA platforms that are supposed to help build solutions without having to resort to advanced programming. There are various popular solutions on the market. Each has its own specificity and skills paths.

The most popular solutions include, among others:

1. **UiPath** – a user-friendly RPA tool that enables companies to quickly and efficiently automate manual processes. It provides a drag-and-drop interface that facilitates flowcharts and diagrams, and its built-in activity library makes it possible for users to

23 Customer Journey Map – customer migration mapping, a tool used to visualize all interactions that a customer has with our brand both on the website and outside of it.

24 User Story is a short, informal and simple description of system functions (application, portal, mobile application) from the point of view of a person who needs new capabilities in a product.

automate a wide range of processes, including data entry, **web scraping**[25] and e-mail marketing.

2. **Automation Anywhere** – an end-to-end platform for Robotic Process Automation (RPA). The platform offers a wide range of functions including process exploration, artificial intelligence (AI), natural language processing (NLP) and machine learning (ML). It also provides a complete set of tools for bot creation, implementation and management.

3. **Blue Prism** – it is also software for Robotic Process Automation. The tool requires some programming knowledge to initiate an automation project and is considered to be developer friendly. It is used in almost all sectors, including: financial services, telecommunications, insurance, manufacturing, hospitals, etc.

4. **Microsoft Power Automate** – a Robotic Process Automation (RPA) tool. It can be used to automate multiple business processes, including data entry, document processing, email management and more. Power Automate is easy to use and can be deployed quickly, making it ideal for businesses of all sizes. It is available in desktop, mobile and online format. This solution is used, among others, by: Coca-Cola, T-Mobile and Capitol Music Group.

5. **KNIME platform** – currently one of the world's best open source platforms. It enables both automation of business processes (including data entry, document processing, web scraping) and AI use in Robotic Process Automation (RPA). KNIME provides a user-friendly **graphical interface (GUI[26])** during the construction and development of projects. KNIME provides many pre-defined components called nodes that can be used for various tasks, such as: reading data, applying different machine learning algorithms and visualizing data in different formats.

25 The act of retrieving information from a website or computer screen and placing it in an ordered document on a computer.

26 Graphical User Interface (GUI) is a graphical environment as a means of presenting information and an interface that ensures interaction with the user.

Table 4. Learning achievements for cluster coordinators. Programming – Advanced level

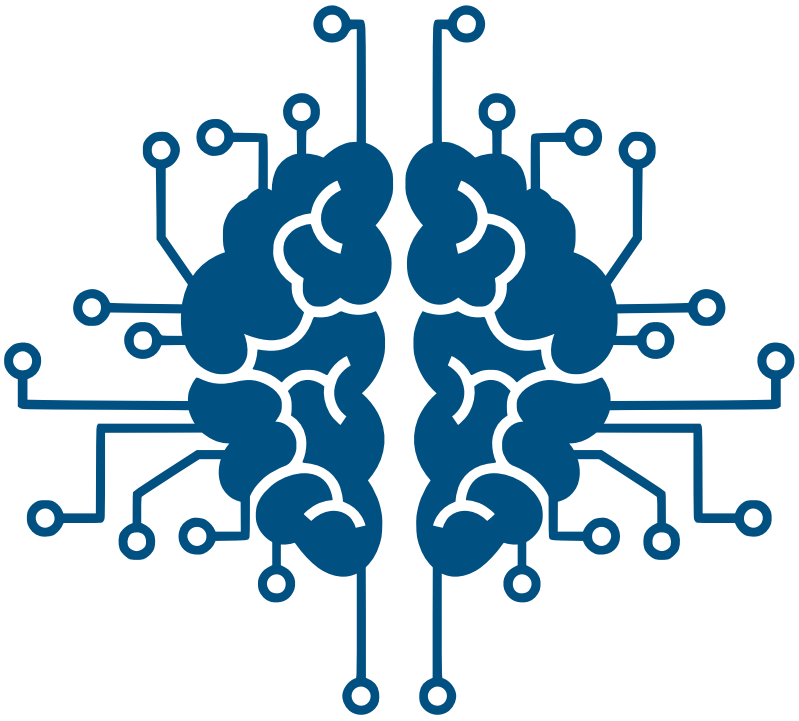
	Knowledge
1	Defines the mechanism: client, server, request and response.
2	Recognizes classic components of applications and IT systems design approaches (front-end, back-end, thin/thick client).
3	Describes how HTTP works (headers, request content versus response content).
4	Describes the operation of basic technologies used on the Internet (HTML and CSS as descriptive languages for websites).
5	Presents JavaScript as a scripting language.
6	Presents the JSON, XML notation as a syntax of the data description.
7	Defines the basics of network security (HTTPS, tokens, local storage and cookies).
8	Describes the operation of the database management system (RDBMS, client-server architecture using PostgreSQL).
9	Shows the types of SQL operations – data operations (DML) and structure definition (DDL), concept and mechanism of transactions, DDL – database structure operations (CREATE).
	Skills
1	Uses Chrome Developer Tools: 1. Spoofing: equipment, network conditions. 2. Inspection of components. 3. Developer console. 4. Inspection of network calls.
2	Uses Postman at work: basics of use – creating and inspecting requests and creating and maintaining a test library.
3	Models data (database types, basics of relational database).
4	Describes the operation of the database query language – SQL using the PostgreSQL example.
5	Executes SQL queries (DML – SELECT queries, DML – data operations (INSERT, UPDATE, DELETE)).
6	Uses selected mechanisms of the low-code platform (Canvas class applications, model-driven application).
7	Uses selected mechanisms of the RPA tool (designs, implements a software robot application).
8	Defines the concept of participatory automation.
9	Specifies automation with and without support.
10	Specifies scenarios in which share automation is recommended.
11	Lists the share automation functions offered by the RPA platform.

Source: own study.

2.3. Cluster troubleshooting with programming: examples

The **citizen developer** approach assumes that company teams will create reusable components (applications, improvements, software robots, services) that can be used by others. Such solutions may be developed by employees who have knowledge of a specific field, but do not have formal programming skills.

Figure 4. Machine learning



Source: pixabay.com

Once they have acquired new competences in low-code and/or RPA, they can start developing applications and automation themselves, or work in teams with IT professionals. Hybrid team solutions can continue to benefit from the same quality processes and automation of programming tasks as those used by solutions developed by professional developers.

Table 5. Examples of the use of programming in cluster coordinator tasks

	Problem description	Implementation method	Tools	Benefits
Example 1	Reporting information on new competitions on grant websites and updates on these grant programs.	Desktop or cloud software. Software robot. Content scanner on web pages (web scraping) and social media channels of cluster members.	RPA	Summary of open competitions and program updates in the form of a report or spreadsheet.
Example 2	Issuing and sending member contribution invoices.	Desktop or cloud software. Software robot.	RPA	Automatic generation of invoices for cluster members.
Example 3	Media monitoring with regard to publications on the cluster and its members.	Desktop or cloud software. Software robot. Content scanner on web pages (web scraping) and social media channels of cluster members.	RPA	List of proposals that may be material for social media, cluster website or press releases, e.g. as “cluster life” material.
Example 4	Sending automated queries for estimating the value of services.	Desktop or cloud software. Software robot. Scanner using API access to central registers. Web content scanner (web scraping).	RPA + Low-code	Automatic sending of queries for estimating the value of a service to help you add a query to a competitiveness base.
Example 5	Analysis of changes to corporate data of cluster members and up-to-date contact details.	Desktop or cloud software. Software robot. Scanner using API access to central registers.	RPA + Low-code	Preparation of updated cluster members datasheet.

Source: own study based on workshops.

2.4. Paths to improve programming literacy level

Digital competences in the low-code/RPA area are usually grouped in two areas. From the point of view of cluster coordinators, the most practical approach seems to be to first build competences in the business area (basic and intermediate-level competences) and then more developer ones (programming – advanced level). The proposed levels are:

1. **Basic level** – adequate for most employees. It is about knowing ideas and basic ideas and concepts that make it possible to communicate in a common language with developers and IT professionals.
2. **Intermediate level** – related to business analysis and modeling of data and processes that make it possible to participate in projects by working in analytical teams.
3. **Advanced level** – depending on the development path and area, you can extend the knowledge with competences to work in digital transformation projects (together with IT professionals) or even with competences to create simple analytical and automation solutions on your own, using low-code/RPA platforms.

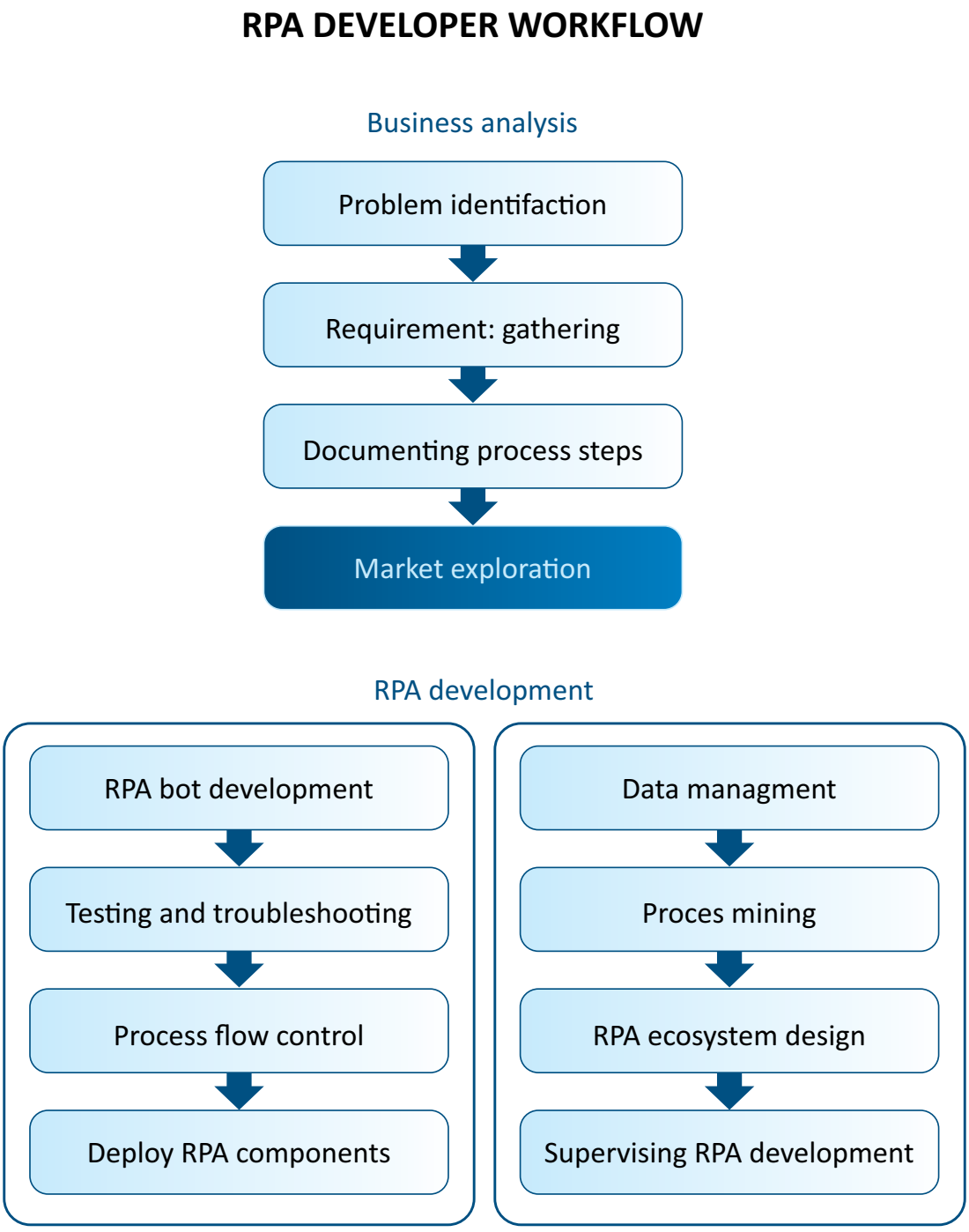
The level of knowledge of concepts and low-code/RPA platforms is the basis for determining competence levels. This is why proposals for division of areas of competence appear in literature and online materials. Unfortunately, major solution providers such as Microsoft, KNIME, UiPath are building their own educational paths that overlap only in some areas. The scope of competence model for the RPA Developer specialization, based on the educational paths of the UiPath, Automation Anywhere and Blue Prism platforms, is shown below as an example.

It is should be pointed out that in this case most of the competences needed to build RPA solutions are necessary when using low-code platforms. In particular, these are competences related to:

1. **process flow control** – business processes and their course in the application,
2. **data management** – development and management of data models,

3 **process mining** – discovering how business processes work and how they can be supported by low-code/RPA solutions.

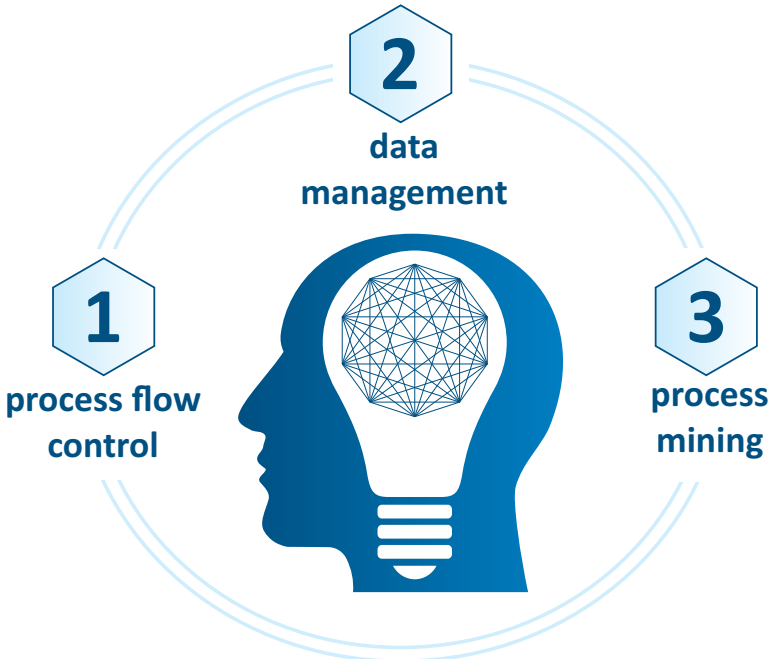
Diagram 6. RPA areas of competence: Business analysis (Level 1 and 2), RPA development (Level 2 and 3). RPA Developer roles, competencies and path certification



Source: RPA Developer Role Skills and Certification | AltexSoft.

Competences at more business-related levels (Basic and Intermediate) not only help but are actually necessary to participate not only in low-code/RPA solution implementation projects, but also in other IT projects.

Figure 5. Necessary competences when using low-code platforms



Source: own study and pixabay.com

The natural stage of competence development is to enter the level of designing, building and testing of applications. The multitude of free and commercial courses on YouTube or educational platforms, such as Udemy, O'Reilly Online, Coursera, etc., offers quite wide options to improve competences. Commercial and open source vendors offers also guides and courses that are directly related to their tools, such as UiPath, Microsoft Power Platform, KNIME, Power BI, Qlik Sense, Tableau. The following are some proposals where everyone should find something interesting for themselves, regardless of the initial level of knowledge and skills.

Level 1 – Basic (knowledge of basics)

Examples of materials:

1. RPA Business Analyst Foundation, https://academy.uipath.com/learning-plans/rpa-business-analyst-foundation
2. Introduction to Microsoft Power Platform – Training | Microsoft Learn, https://learn.microsoft.com/en-us/training/modules/introduction-power-platform/
3. Introduction to Power Apps – Training | Microsoft Learn, https://learn.microsoft.com/en-us/training/modules/introduction-power-apps/
4. Introduction to Power Automate – Training | Microsoft Learn, https://learn.microsoft.com/en-us/training/modules/introduction-power-automate/
5. Introduction to Power BI – Training | Microsoft Learn, https://learn.microsoft.com/en-us/training/modules/introduction-power-bi/

Next steps:

RPA Citizen Developer Foundation, https://academy.uipath.com/learning-plans/rpa-citizen-developer-foundation

Level 2 – Intermediate (outsourcing cooperation)

Examples of materials:

1. RPA Business Analyst Foundation, https://academy.uipath.com/learning-plans/rpa-business-analyst-foundation
2. RPA Citizen Developer Foundation, https://academy.uipath.com/learning-plans/rpa-citizen-developer-foundation
3. Microsoft Power Platform Functional Consultant – Certifications | Microsoft Learn, https://learn.microsoft.com/en-us/certifications/exams/pl-200

4. How to build a canvas app – Training | Microsoft Learn, https://learn.microsoft.com/en-us/training/modules/build-app-solution/
5. How to build a model-driven app – Training | Microsoft Learn, https://learn.microsoft.com/en-us/training/modules/how-build-model-driven-app/
6. How to build an automated solution – Training | Microsoft Learn, https://learn.microsoft.com/en-us/training/modules/build-automated-solution/

Next steps:

1. PL-900: Microsoft Power Platform Fundamentals - Training | Microsoft Learn, https://learn.microsoft.com/en-us/training/paths/power-plat-fundamentals/

Level 3 – Advanced (unassisted use)

Examples of materials:

1. Attended Automation for RPA Developers, https://academy.uipath.com/courses/attended-automation-for-rpa-developers
2. Microsoft Power Platform App Maker - Certifications | Microsoft Learn, https://learn.microsoft.com/en-us/certifications/exams/pl-100

Next steps:

1. RPA Developer Foundation, https://academy.uipath.com/learning-plans/rpa-developer-foundation-

3 BIG DATA and DATA SCIENCE

3. Big Data and Data Science

3.1. Big Data and Data Science competencies

The competences of **data scientists**[27] differ from those of **data analysts**. The former have broader and more specialized competences that require knowledge and skills to be used, e.g. statistical analysis and artificial intelligence tools, in data analysis. Data analysts, on the other hand, usually work on more structured datasets, where the main competences are based on preliminary data processing, reporting and visualization, also using Power BI, Qlik Sense, Tableau class tools. In 2001, Doug Laney, an analyst of the consulting company Gartner, based on the observation of problems of its customers with data from different sources, their structure and different formats, concluded that Big Data[28] was characterized by the **3V**, i.e.:

- large **volume**,
- **velocity**,
- **variety**.

Subsequently, the concept of **veracity** was added to the list, creating **4V**. Over the next two decades, the list has gradually increased to **10V**. Apart from those already mentioned, there are also the following ones:

- Big Data **variability**,
- **validity**,
- **vulnerability** to cyber attacks,
- **volatility** (in the context of cost-effectiveness of archiving such large data sets),
- **visualization** challenges,
- their business **value**.

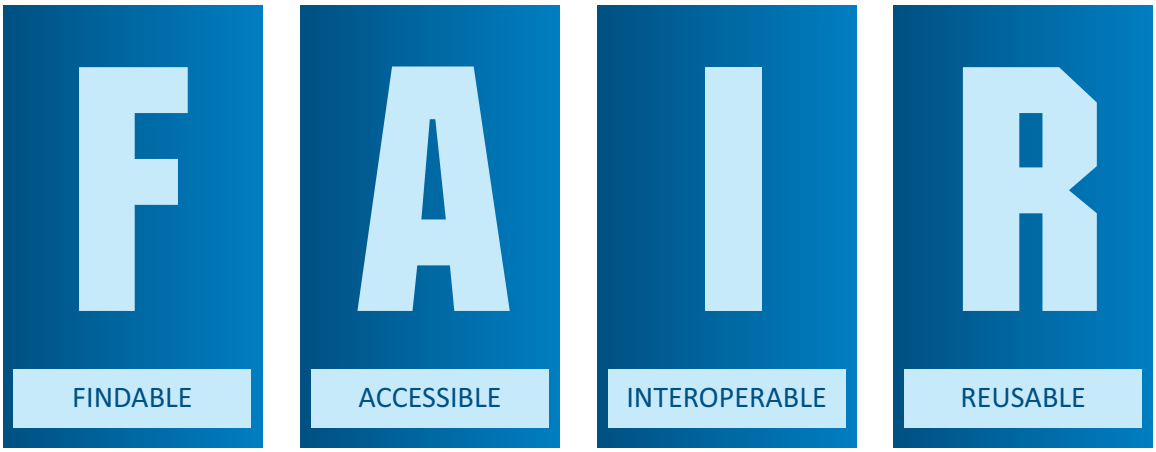
27 *O naukowcach od danych słów kilka, czyli czym tak naprawdę zajmuje się Data Science? Rola Data Science w organizacji [A few words about data scientists: what does Data Science actually deal with?],* Deloitte, https://www2.deloitte.com/pl/pl/pages/technology/articles/czym-zajmuje-sie-data-science.html

28 Doug Laney, *3D Data Management: Controlling Data Volume, Velocity and Variety,* Meta Group, 2001. Available at: https://studylib.net/doc/8647594/3d-data-management--controlling-data-volume--velocity--an...

However, in order to be useful, the data must be **FAIR**. This acronym means:

1. **findable** – easy to find, provided with metadata, with unique, permanent identifiers,
2. **accessible** – available to all according to the specified access conditions,
3. **interoperable** – enabling connection with other data sets, e.g. by standardized naming,
4. **reusable** – they can be used again.

Figure 6. FAIR



Source: own study.

A **data-driven organization** has a team of analysts, or cooperates with persons/entities that provide services from the broadly understood scope of data analysis and use of artificial intelligence tools.

Data literacy is becoming a very important digital competence. It can be assumed that by 2030, building a competitive advantage will also be based on understanding of basic concepts related to data, data collection, use and management. It is important to understand who is responsible for the data, how to cite and describe them properly, and to use them in a legal and ethical manner, especially if they come from external sources.

Data awareness is therefore becoming a challenge for cluster companies, and they need support in this area. This is an important element in creating a competitive industry where the use of data allows for optimization of business models. In the presentation "Visualizations for Industrial Data Science", Clemens Heistracher presented an analysis of the stages of data use in business activities, indicating five levels of progress.

1. **Identification of existing data sources** – What data do we have?
2. **Combining data –** What data can we usefully combine with one another?
3. **Looking for additional data sources** – What data do we still want to collect?
4. **Defining prediction areas based on data** – How can data be used efficiently to grow a business?
5. **Evaluation of data and built models based on them** – Did the developed models work?

3.1.1. Big Data

The opportunities for using Big Data grow with the development of artificial intelligence and new analysis tools and technologies based on them. There is an unprecedented coupling: it was as only after the emergence of vast data sets that allowed the use of machine learning and deep learning (DL). As a result, data are being acquired, processed, analyzed and visualized more quickly and efficiently. It should be pointed out that the most time spent working with data (on average 60%) is taken to clear and organize data, whereas searching for trends in data (data mining for patterns) and improving algorithms is only 13%.

3.1.2. Data Science

Artificial intelligence, machine learning and deep learning have many published definitions. All of them contain elements of tools that make decisions like the human inference process, which is not always flawless.

Artificial intelligence is a semantically wide concept. This includes programs, robots and systems that have the ability to perform tasks and simulate experiences commonly associated with human brain skills, including learning, inference and perception.

Machine learning consists of algorithms and artificial intelligence tools that have the ability to learn without explicitly programming the algorithms to follow. In practice, this means that a computer system learns to test the results of its activities and checks which ones give better results. Algorithms learn "like humans" – e.g. with many examples of a given object, using calculations, they can be able to recognize that object in other, previously unknown circumstances. Part of machine learning is **deep learning**, a set of machine learning tools and methods that learn how to handle large data sets with artificial neural networks[29].

There are also different levels of **artificial intelligence**. The currently achievable level is so-called **narrow AI** – AI specializing in specific tasks, e.g. playing chess, recognizing specific categories of images, analyzing patterns in large amounts of data. Another level is so-called **human level AI** – intelligence at the human level. The final level is so-called **super AI**, an artificial intelligence that outperforms human intelligence capabilities and so far known AI.

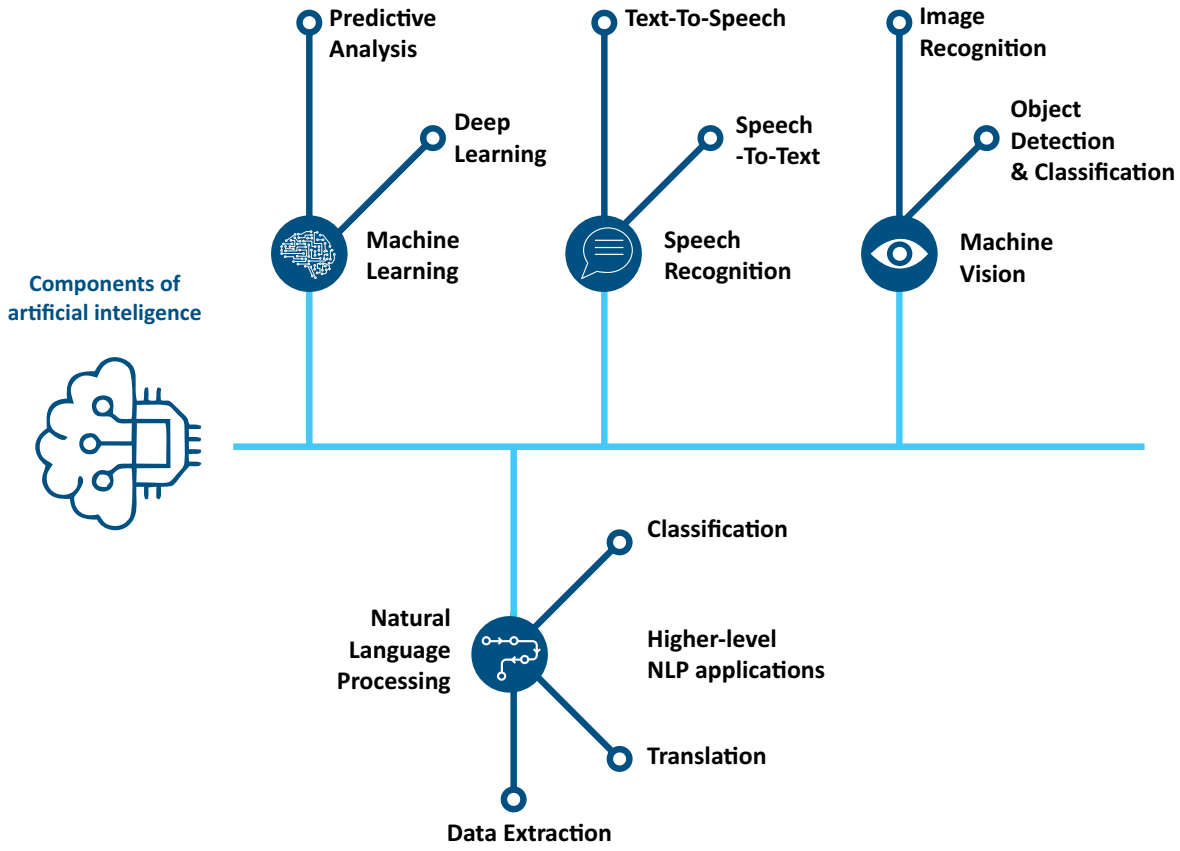
3.1.3. Big Data and Data Science synergy

It is the combination of Big Data and Data Science that exploits the potential of artificial intelligence. This requires data – both small collections and Big Data. Sufficiently large datasets allow learning (trending) and testing of an AI-based system.

29 *Sztuczne sieci neuronowe [Artificial neural networks – Artificial intelligence], SI – Sztuczna Inteligencja, https://www.sztucznainteligencja.org.pl/kurs/sztuczna-inteligencja-dla-poczatkujacych/sztuczne-sieci-neuronowe/*

The various concepts of artificial intelligence are summarized below. Four areas, which are presented in the diagram below, can be consulted in the e-learning material of the Future Industry Platform Foundation entitled "Sztuczna inteligencja, uczenie maszynowe i uczenie głębokie – E-learning Przemysłu Przyszłości" [Artificial intelligence, machine learning and deep learning – E-learning of Future Industry][30]. On the other hand, more about Big Data's application areas and potential can be read in "Wielki wybuch danych -–Od digityzacji do datafikacji" [Big Data explosion – from digitalization to datafication][31].

Diagram 7. Four areas of artificial intelligence: machine learning, speech recognition, machine vision, natural language processing



Source: "Sztuczna inteligencja, uczenie maszynowe i uczenie głębokie – E-learning Przemysłu Przyszłości" [Artificial intelligence, machine learning and deep learning – E-learning of Future Industry].

30 *Sztuczna Inteligencja – E-learning Przemysłu Przyszłości [Artificial Intelligence – E-learning of the Future Industry]*, Future Industry Platform Foundation,, https://elearning.przemyslprzyszlosci.gov.pl/szkolenia/sztuczna-inteligencja/

31 Katarzyna Śledziewska, Renata Włoch, *Wielki wybuch danych – Od digityzacji do datafikacji [Big Data explosion – from digitalization to datafication]*, Future Industry Platform, https://przemyslprzyszlosci.gov.pl/wielki-wybuch-danych/

Artificial intelligence, machine learning and deep learning can be used in services as so-called AutoML (**Auto Machine Learning**) tools also implemented as **Cloud Cognitive Services**.

Cognitive services refer by their name to the definition of cognitive intelligence. Unlike classical algorithms, cognitive services mimic human cognitive functions as they analyze, infer and learn. This facilitates the implementation of AI in the form of software, video systems, processing of data from the Internet of Things sensors and introduces the potential for artificial intelligence to the level of the organization's business processes.

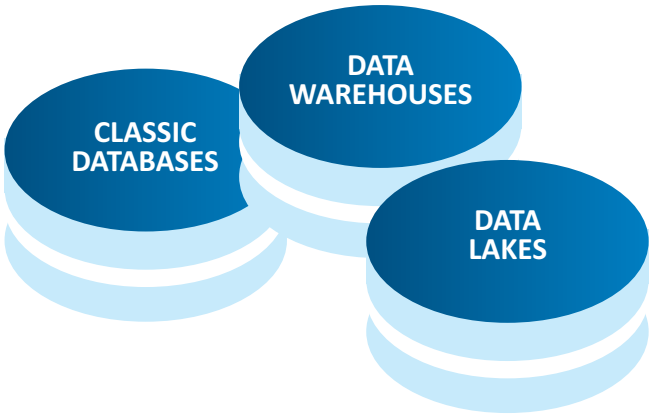
3.2. Big Data and Data Science in the work of cluster coordinators

By implementing the right AI tools, companies and organizations can save time and money and innovate by automating routine processes and tasks. This can result in increased productivity and operational efficiency, as well as faster business decisions based on data output from data analysis or AI-based systems.

In Austria, the frequently asked question is how to learn about new trends in Big Data/Data Science while offering tangible benefits to clusters and their member companies. Business Upper Austria approached this issue by joining the International Data Spaces Association (IDSA).

Data spaces are an increasingly important topic for different industries as they are designed to unlock different performance gains. However, the topic is rather complex and building the competences necessary to understand the data space can be a challenge. By joining IDSA, Business Upper Austria, a regional economic agency running eight Austrian clusters, provides employees of its clusters with direct access to up-to-date data space information.

Figure 7. Big Data storage



Source: own study.

On the one hand, that access to information may directly increase the competences of cluster employees. On the other hand, cluster managers can provide information to their member companies and thus provide additional services to them.

Therefore, this approach may be a good practice for building competences and offering services at the same time.

Data, both small collections and Big Data, are key to exploiting the potential of artificial intelligence. Most cluster coordinators do not operate on large datasets and therefore have limited opportunities to use both exploratory data analysis[32] and AI tools. It should be kept in mind that only suitably large datasets make it possible to learn (trend) and test an AI-based system.

In order for this process to run properly, it is also important to properly store Big Data. Large datasets can be stored in various ways. One of them is classic **databases**, known, among others, from programs supporting the activities of companies. Another way to store Big Data are **data warehouses[33] and data lakes.**

Data lakes are a very important tool in the process of Big Data use. They collect raw data (i.e. data in its native form) and events captured from various source systems. Data lakes[34]

32 For definition of the concept Exploratory Data Analysis (EDA), see page 74 of the Guide.

33 *Jak sprawnie wdrożyć Modern Data Warehouse bez większego bólu głowy? [How can Modern Data Warehouse be implemented smoothly without major headaches?],* Deloitte, https://www2.deloitte.com/pl/pl/pages/technology/articles/jak-sprawnie-wdrozyc-modern-data-warehouse.html

34 Laurence Goasduff, *The Best Ways to Organize Your Data Structures*, Gartner, https://www.gartner.com/smarterwithgartner/the-best-ways-to-organize-your-data-structures

typically support data preparation, exploration analysis and Data Science activities.

The following is a project of a three-level development path of competencies in Big Data and Data Science.

Level 1 – Basic (knowledge of basics)

Acquiring the competences necessary to participate in projects related to the implementation of AI in an organization begins by acquiring knowledge of concepts, opportunities and rules for the application of Big Data, Data Science and artificial intelligence (basic level). All employees should have knowledge at least at this level.

Table 6. Learning achievements for cluster coordinators. Big Data/Data Science – basic level

	Knowledge
1	Defines concepts related to data collection (including loading, transformation, aggregation), use (including analysis, data mining, machine learning) and management (including transmission, sharing), especially those related to data processing, evaluation and use.
2	Defines the concept and stages of development of artificial intelligence (narrow AI, human level AI, super AI).
3	Knows the most important milestones in AI development.
4	Defines the concept and characteristics of artificial neural network.
5	Defines machine learning and deep learning.
6	Describes the use of data models in the design of data warehouse and other data storage types (Data Lake, Snowflake Data Lake).
	Skills
1	Understands and can assess the implementation method of basic concepts related to data, their collection, use and management, in particular concerning the processing, evaluation and use of data for different purposes, including the use by advanced algorithms.
2	Describes the ETL (Extract – Transform – Load) data processing processes relevant to data processing.
3	Evaluates the basic characteristics of data (in terms of basic parameters – 4V characteristics), giving useful and meaningful observations.
4	Evaluates information on data, including limitations of the scope of processed data in relation to business needs, data types and data source.

Source: own study.

Level 2 – Intermediate (outsourcing cooperation)

The intermediate level is intended for persons who actively participate in projects. Their knowledge should be extended to include capabilities of selected data processing methods and AI tools. With knowledge at this level, it is easier to assess if and how specific tools and technologies can help us solve a specific problem, as well as work in a team with Big Data, Data Science and AI specialists.

Table 7. Learning achievements for cluster coordinators. Big Data/Data Science – intermediate level

	Knowledge
1	Defines the terms: data mining, text mining, data extraction.
2	Describes how AI works.
3	Describes the operation of AI mechanisms (especially the learning and testing process).
4	Indicates typical examples of AI usage.
5	Describes Natural Language Processing (NLP) methods, its tools and applications.
6	Defines Convolutional Neural Networks as the basis for classifying images.
7	Describes how machine learning works (definition and key features).
8	Describes how deep learning works (definition and key features).
	Skills
1	Specifies the demand for AI utilization in the cluster.
2	Discusses examples of supporting AI data mining.
3	Discusses examples of supporting Natural Language Processing by AI.
4	Discusses examples of supporting decision making process by AI.
5	Discusses individual elements and tools of the scope covered by EDA (Exploratory Data Analysis).

Source: own study.

Level 3 – Advanced (unassisted use)

Due to the combination of programming and mathematical knowledge and the knowledge of tools, developing machine learning models is considered very difficult. Such actions require programming competence and knowledge of data analysis. There are packages available on the market that can help build advanced solutions without having to resort to advanced programming.

KNIME Platform, an open source platform, is now considered to be one of the best solutions in the world, making machine learning models accessible to ordinary people. It enables both automation of business processes (including data entry, document processing, web scrapping) and AI use in Robotic Process Automation (RPA). During the creation and development of projects, KNIME provides a user-friendly graphical user interface (GUI). The platform also provides a number of pre-defined components called nodes that can be used for various tasks, such as: data reading, using different machine learning algorithms, visualizing data in different formats.

Another path is to build competencies using the Python ecosystem and a ready set of libraries for data processing, analysis and visualization, as well as machine learning or deep learning, among others, in clustering and classification.

Table 8. Learning achievements for cluster coordinators. Big Data/Data Science – advanced level

	Knowledge
1	Describes the AI implementation potential and constraints.
2	Discusses ethical issues (e.g. purposefulness of use) related to AI operation[35].
3	Evaluates the impact of adopting a specific scenario for the use of AI tools, e.g. supervised and unsupervised learning.
4	Discusses the socioeconomic impact of AI.
5	Characterizes AI potential and implications for different sectors of the economy.
	Skills
1	Builds a workflow on the KNIME Analytics Platform.
2	Performs data conversion and cleaning tasks on KNIME.
3	Trains deep learning and interactive visualization algorithms on KNIME.
4	Creates, evaluates, and tunes ML models with Visual ML, Azure ML Studio, and KNIME.
5	Implements models from laboratory to production.
6	Uses Python as well as NumPy and Pandas libraries in data analysis.
7	Uses the scikit-learn package in Python to train the regression model from the dataset.
8	Executes examples of the use of the scikit-learn package in Python.

Source: own study.

35 *The Royal Society: Explainable AI: the basics*, Futurium, https://futurium.ec.europa.eu/en/european-ai-alliance/document/royal-society-explainable-ai-basics

3.3. Cluster troubleshooting with Big Data/Data Science: examples

Artificial Intelligence tools[36] can be used to solve the majority of tasks where event **clustering**, **classification or prediction** is important. The field of application, which has great potential to support coordinators in performing their tasks, seems to be **computer vision**) or **Natural Language Processing**. These tools allow the processing and digitization of paper documents or the analysis of the content of web pages and social media to "extract" information on trends, technologies and activities of cluster members.

Cluster coordinators can also use AI tools in the form of models previously trained on area and industry specific Big Data sets. For logistic and administrative tasks, artificial intelligence can be used, for example, in business process automation (RPA). An example is the use of cognitive (mostly cloud) services, which allow the use of previously trained models.

There are many possible **Cloud Cognitive Services** applications. From advanced systems on production lines in the factory (***Predictive Maintenance***)[37], through video monitoring systems (biometric or for public safety surveillance), to simple applications that can be used on a daily basis. An example of everyday application of this solution is, for example, image search carried out by the Google Lens mobile application.

For more information on cognitive services, see the Article "*Sztuczna inteligencja w zasięgu każdej firmy MŚP: chmurowe usługi kognitywne*" (Artificial Intelligence available to every SME: Cloud Cognitive Services)[38].

36 *Sztuczna Inteligencja – E-learning Przemysłu Przyszłości [Artificial Intelligence – E-learning of the Future Industry]*, Future Industry Platform Foundation, https://elearning.przemyslprzyszlosci.gov.pl/szkolenia/sztuczna-inteligencja/

37 Mariusz Hetmańczyk, *Predictive Maintenance: podejście umożliwiające optymalną eksploatację obiektów technicznych [The Predictive Maintenance approach that enables optimum operation of technical facilities]*, Future Industry Platform, 2021. Available at: https://elearning.przemyslprzyszlosci.gov.pl/predictive-maintenance-podejscie-umozliwiajace-optymalna-eksploatacje-obiektow-technicznych/

38 Paweł Tadejko, Sztuczna inteligencja w zasięgu każdej firmy MŚP: chmurowe usługi kognitywne [Artificial Intelligence available to every SME: Cloud Cognitive Services], E-learning for the Future Industry, Future Industry Platform, 2021. Available at: https://elearning.przemyslprzyszlosci.gov.pl/sztuczna-inteligencja-w-zasiegu-kazdej-firmy-msp-chmurowe-uslugi-kognitywne/

Table 9. Examples of using Big Data/Data Science in the tasks of cluster coordinators

	Problem description	Implementation method	Tools	Benefits
Example 1	Using information on cluster members from public registers (e.g. SUDOP[39])	Software robot (RPA) supported by NLP (Natural Language Processing) algorithms. Web content scanner (web scraping) and API access to central logs.	RPA, l ow-code, NLP (Natural Language Processing) and the use of access by API.	List of members of the cluster together with the public aid amount.
Example 2	Supporting the creation of sales groups in the logic of ad-hoc consortia.	Cluster coordinator data sets (as sheets or databases) with information about the potential of cluster members. Form with the option to have the resources updated by cluster members. Using automation tools to analyze the potential of cluster members.	Common data repository (or database) and RPA and/or low-code tools.	Reports with suggestions for the possibility of using common potential when executing the order
Example 3	Supporting the exchange of resources between members of clusters.	A common repository of data on services, experts and teams (as sheets or databases). Form with the option to have the resources updated by cluster members. Repository search engine.	Common data repository (or database) and RPA and/or low-code tools.	Possibility to search for available members (e.g. a database of specialists, equipment, expert services) that can be used within the cluster members.

39 The SUDOP (Public Aid Data Sharing System) database contains information on: aid measures implemented in Poland, aid granted as part of aid measures implemented in Poland, any public aid and de minimis aid granted to a given beneficiary. The information shared through the SUDOP system comes from reports on the aid granted, prepared through the SHRIMP application by entities granting the aid under Article 32 of the Act of April 30, 2004 on the procedural issues concerning public aid (Journal of Laws of 2018, item 362). The printouts with data on the aid received by the beneficiary are for information only. This means that the presentation of the printout to the entity granting the aid does not mean the fulfillment of the obligation to present a certificate/declaration on the de minimis aid received, referred to in Article 37 of the Act of April 30, 2004 on the procedural issues concerning public aid (https://sudop.uokik.gov.pl/home).

Example 4	Entering paper documents into IT systems.	OCR of forms. A tool for designing a workflow or recognizing forms. Software robot (RPA) supported by computer vision.	RPA, low-code, computer vision tools.	Easier input of data (automatic or semi-automatic) from paper documents into IT systems or transfer of the contents of entire documents to IT systems.
Example 5	Analysis of sentiment[40] in publications on the cluster and its members.	Software robot (RPA) supported by NLP and machine learning algorithms. Scanner using API access of RSS aggregators. Web content scanner (web scraping).	RPA, l ow-code, NLP (Natural Language Processing)	Analysis of sentiment as the most commonly used tool for quick and effective identification of negative reviews or articles on the Internet.

Source: own study based on workshops.

3.4. Big Data/Data Science competence upgrades

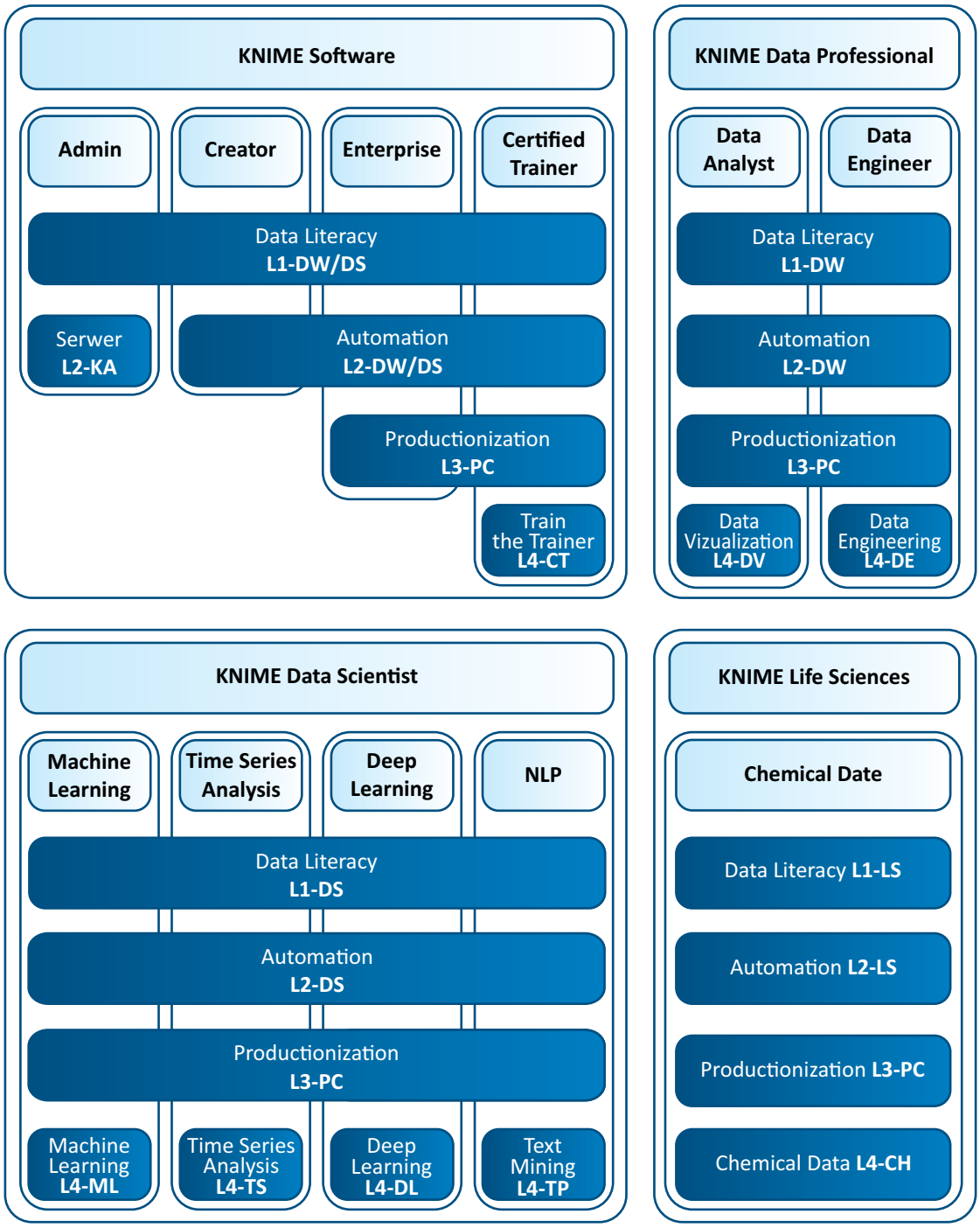
Digital competence in Big Data and Data Science consists of a large number of thematic areas. This is partly due to the specific nature of artificial intelligence tools, where, for example, deep learning and natural language processing are two separate areas. This requires the use of specialized methods, algorithms, data structures, mathematical tools and ultimately ICT tools – software, server environments, specialized clusters and cloud services. Most often, competences are grouped in two areas – **data analysis and processing** and **data science** as referred to in sub-chapter 2.1. "Competence in Big Data and Data Science area".

From the point of view of Cluster Coordinators, the most practical approach seems to be the initial development of competencies in data analysis and processing (**data analyst** and **data engineer** – competencies of data analyst and engineer preparing data for further analysis) –

40 The analysis of sentiment uses Natural Language Processing, text analysis, computer linguistics and biometrics to systematically identify, isolate, quantify and study affective conditions and subjective information..

as in the example of the KNIME Learning Paths[41]. This is a natural extension of data literacy, where data analysts and data engineers are all data specialists in their field. Practically speaking, these are all employees of the Cluster Coordinators.

Diagram 8. KNIME Learning Paths



Source: KNIME.

41 Rosaria Silipo, Schalk Gerber, Satoru Hayasaka, *Take Charge of Your Data Professional Journey,* KNIME, https://www.knime.com/blog/learning-paths-for-data-professionals

On the other hand, data analysis and processing are linked to the automation competences. Cluster workers are not **data scientists** , in the sense that they do not directly deal with machine learning algorithms. However, they must have access to and be able to store, convert, keep and visualize data so that they can monitor and measure business activities.

Given the proposed competence levels for the personnel of Cluster Coordinators, specific knowledge and skills can be built in various ways, e.g. depending on the preferences of employees. The multitude of free and commercial courses on YouTube or educational platforms, e.g. Udemy, O'Reilly Online, Coursera, etc., offers quite wide options to improve competence. Commercial and open source vendors develop guides and courses that are directly related to their tools, such as UiPath, Microsoft Power Platform, KNIME, Power BI, Qlik Sense, Tableau. Below there are some proposals where everyone should find materials appropriate for them, regardless of the initial level of knowledge and skills.

Level 1 – Basic (knowledge of basics)

Examples of materials:

1. How to Close the Data Literacy Gap | KNIME, https://www.knime.com/blog/close-data-literacy-gap
2. "*Sztuczna inteligencja, uczenie maszynowe i uczenie głębokie — E-learning Przemysłu Przyszłości*" (Artificial intelligence, machine learning and deep learning – E-learning of the Future Industry),

   https://elearning.przemyslprzyszlosci.gov.pl/szkolenia/sztuczna-inteligencja/zagadnienia/lekcja-1-uslugi-kognitywne-wprowadzenie/tematy/sztuczna-inteligencja-uczenie-maszynowe-i-uczenie-glebokie/
3. "*Wielki wybuch danych — Od digityzacji do datafikacji*" (Big Data explosion – from digitization to datafication),https://przemyslprzyszlosci.gov.pl/wielki-wybuch-danych/
4. "*Charakterystyka lidera i zespołu transformacji — E-learning Przemysłu Przyszłości*" (Characteristics of the leader and transition team – E-learning of the Industry of the

Future), https://elearning.przemyslprzyszlosci.gov.pl/szkolenia/transformacja-w-obszarze-cyfrowego-obiegu-danych-cyfryzacja-procesow-inzynierskich/zagadnienia/etap-uswiadamianie-3/tematy/charakterystyka-lidera-i-zespolu-transformacji-2/

5. Beginner's Guide to Data & Data Analytics, by SF Data School | Udemy, https://www.udemy.com/course/learndata/

Next steps:

1. What concepts should be learned and what competences should be built? Big Data Scientist – E-learning of the Industry of the Future, https://elearning.przemyslprzyszlosci.gov.pl/slownik-pojec/big-data-scientist/
2. Take Charge of Your Data Professional Journey | KNIME, https://www.knime.com/blog/learning-paths-for-data-professionals
3. Beginner's Guide to Data & Data Analytics, by SF Data School | Udemy, https://www.udemy.com/course/learndata/

Level 2 – Intermediate (outsourcing cooperation)

Examples of materials:

1. Data Science Training Course: Data Scientist Bootcamp | Udemy, https://www.udemy.com/course/the-data-science-course-complete-data-science-bootcamp/

Next steps:

1. Take Charge of Your Data Professional Journey | KNIME, https://www.knime.com/blog/learning-paths-for-data-professionals
2. Data Science Training Course: Data Scientist Bootcamp | Udemy, https://www.udemy.com/course/the-data-science-course-complete-data-science-bootcamp/
3. Statistics & Mathematics for Data Science & Data Analytics | Udemy, https://www.udemy.com/course/statistics-for-data-science-data-analytics/

Level 3 – Advanced (unassisted use)

Examples of materials:

1. Know Your Data with Descriptive Statistics in KNIME | KNIME, https://www.knime.com/blog/know-your-data-descriptive-statistics
2. Data Science Training Course: Data Scientist Bootcamp | Udemy, https://www.udemy.com/course/the-data-science-course-complete-data-science-bootcamp/
3. Statistics & Mathematics for Data Science & Data Analytics | Udemy, https://www.udemy.com/course/statistics-for-data-science-data-analytics/
4. Statistics & Mathematics for Data Science & Data Analytics | Udemy, https://www.udemy.com/course/statistics-for-data-science-data-analytics/

Next steps:

1. Train and evaluate clustering models - Training | Microsoft Learn, https://learn.microsoft.com/en-us/training/modules/train-evaluate-cluster-models/
2. Train and evaluate deep learning models - Training | Microsoft Learn, https://learn.microsoft.com/en-us/training/modules/train-evaluate-deep-learn-models/
3. Use Automated Machine Learning in Azure Machine Learning - Training | Microsoft Learn, https://learn.microsoft.com/en-us/training/modules/use-automated-machine-learning/
4. Explain Stroke Prediction Models with LIME in KNIME | KNIME, https://www.knime.com/blog/XAI-LIME-stroke-prediction
5. Data Science Training Course: Data Scientist Bootcamp | Udemy, https://www.udemy.com/course/the-data-science-course-complete-data-science-bootcamp/
6. Statistics & Mathematics for Data Science & Data Analytics | Udemy, https://www.udemy.com/course/statistics-for-data-science-data-analytics/

4 DATA VISUALIZATION

4. Data Visualization

4.1. Competences in the area of data visualization

Data visualization consists in converting data into various graphic forms. Its purpose is to increase the readability of data, make the form of their reception more attractive and enable their exploration by means of visual methods. Visualizations make analysis much easier and faster, offering the possibility to see important elements and regularities. Data visualization is used in areas of organization activities such as: **business analysis** (**ERP**[42] and **BI**[43] systems), **Internet traffic analysis** (**Google Analytics**), and **marketing analysis**[44].

The more key employees are aware of the potential of data analysis, the more effective the use of data in the organization is. In this case, we can speak of **data-driven organization**. In practice, this means that it also refers to data literacy competences, where it is crucial to understand how data can be used, what value they bring, what organizational processes they describe and who is responsible for them.

Visualization of business data consists in presentation of data with the use of diagrams, maps, pictograms, pictures or infographics. The purpose of the visualization is to present a large amount of data in a way that is accessible to the public. Presenting the so-called complex or multi-dimensional data is increasingly a challenge. These are quite different approaches than line or bar graphs[45] known from the basic applications.

42 The Enterprise Resource Planning (ERP) system is the enterprise management software and, in particular, the enterprise resource planning software.

43 Business Intelligence (BI) is the process of converting available data into information and knowledge intended to support decision making processes.

44 Neelam Tyagi, *Real World Applications of Business Analytics*, Analytics Steps, https://www.analyticssteps.com/blogs/real-world-applications-business-analytics

45 *Wizualizacja danych biznesowych 2022 – przykłady [Visualization of business data 2022 – examples]*, Transparent Blog Data – Medium, https://medium.com/blog-transparent-data/wizualizacja-danych-biznesowych-2022-przyk%C5%82ady-703d7d1fb219

One of the most popular and effective tools for business data visualization is the so-called **manager's dashboard**, which allows organizations to track, analyze and report KPIs and developed metrics. High-tech interactive cockpits facilitate the integration of data from multiple sources and also facilitate data mining and analysis directly within the cockpit itself.

The purpose of using the dashboard is to identify the most important factors affecting the company's performance, both in the financial area and other KPIs defined in the organization. Data visualization with the use of management cockpits can bring immediate benefits to the organization, helping, among others, to:

- **Convert data into business value** – cockpits help users focus on key data and make better use of it to take business decisions.
- **Enhance the involvement of key stakeholders** – cockpits, through synthetic and graphical representation of data, can be a highly effective tool to support and reinforce arguments in discussions with decision makers.
- **Improve awareness of the use of data** – sharing cockpits with structured, reliable data supports the development of a data-driven organization culture (including data literacy) at all levels of the enterprise.

Specific tasks should be performed before the management cockpit tool can be deployed. The basis is the modeling of processes and determination of reference data for calculating the KPIs presented.

One of the accelerators for building meaningful data analysis in organizations is process automation (RPA). Business process models come here with help. To automate the process, it should be standardized and algorithmized, i.e. arranged. Automation brings together a lot of additional information on how to measure and evaluate processes. Thus, combining business with analysis by using transparent KPIs in management cockpits will be much simpler.

The actions that the organization must take during the implementation of the transformation strategy towards a data-driven organization are described in more detail, e.g. in the e-learning materials of the Future Industry Platform Foundation[46].

46 *Transformacja w obszarze cyfrowego obiegu danych: Cyfryzacja procesów administracyjnych i biznesowych [Digital data flow transformation: Digitalization of administrative and business processes],* Future Industry Platform Foundation, https://elearning.przemyslprzyszlosci.gov.pl/szkolenia/transformacja-w-obszarze-cyfrowego-obiegu-danych-cyfryzacja-procesow-administracyjnych-i-biznesowych/

4.2. Data visualization in the work of cluster coordinators

For many years, clusters have been seen as an important element of innovation systems. Such a role has already been recognized and described in detail in the OECD publication of 1999. Currently, the European Commission considers clusters to be important players in boosting innovation and competitiveness in regional economies.

Data analysis and visualization is one of the most effective tools used to support decision making, in particular those related to business performance, environmental impact, technology and trends (including technology trends). The biggest challenge of using this category of tools is the acquisition and aggregation of data that is necessary to create valuable visualizations and presentations of data.

Therefore, the acquisition of competences necessary to participate in projects related to the implementation of projects and the use of data- driven tools in the organization starts with the acquisition of a specific scope of knowledge. It concerns the concepts, possibilities and principles of data use, as well as the use of Big Data and data analysis (basic level). This is undoubtedly a shared competence of Big Data/Data Science and data visualization. All employees of cluster coordinators should have knowledge at least at this level.

Data analysis can be carried out in a very different way in the company. It should be remembered that, depending on the area of data analysis and the needs of the company, various solutions can be implemented, ranging from simple reporting and statistical systems to **data self -service**[47] systems.

Austrian clusters are also working on the use of data visualization in everyday work. Standortagentur Tirol, which hosts six Austrian clusters, has found an interesting way to do it. The "Trendlabor Tirol" Trend Laboratory[48] is a tool that offers three central services to cluster members: "trend radar" allows companies to see current and future technological developments that are likely to affect their operations, "Idea shop" enables companies to cooperate in an open environment, and "innovation compass" shows specific innovations and their con-

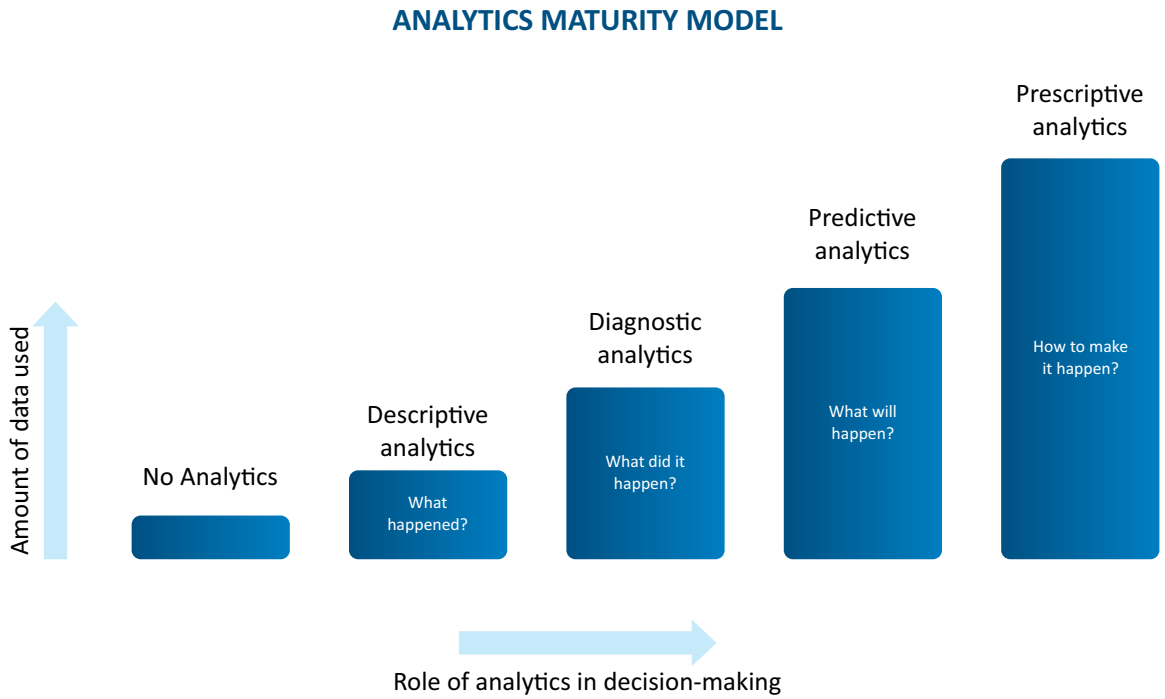
47 In this model, managers and other employees can use easy-to-use tools to define data sets, report on operations, and analyze data themselves.

48 More information on the Trend Laboratory can be found at: https://www.standort-tirol.at/trendlabor

sequences for individual companies. The Trend Laboratory helps cluster members not only by providing relevant information and valuable services, but also helps cluster managers and employees develop their digital competences and stay up to date with new trends.

It is worth noting that there are also other maturity models of digital transformation or digitization. However, it should be borne in mind that they are based on a selective approach to different areas of the company. The model proposed by Gartner is commonly used to describe the organization's maturity path for analytics itself (and not for the entire digital transformation).

Diagram 9. Analytics Maturity Model: Levels, Technologies, Applications



Source: own study based on https://www.altexsoft.com/blog/analytics-maturity-model/

The path can be divided into 5 stages:

1. **No analytics** – it refers to companies that **do not have analytical processes** at all. This level is sometimes added to the above diagram to contrast it with the first stage of analytical maturity.
2. **Descriptive analytics** – it allows to learn **what happened** by collecting and visualizing historical data.

3. **Diagnostic analytics** – it identifies patterns and relations in available data, explaining **why something has happened**.
4. **Predictive analytics** – produces probable **predictions of what may happen in the future using** machine learning techniques to support large volumes of data.
5. **Normative analytics** – provides optimization options, decision support, and **insights into how to achieve the desired outcome**.

Analytics maturity models may translate into ways of visualizing the results of analyses. Starting with the simplest tools (graphs), which reflect the meaning of descriptive analytics, and ending with very advanced (specialized) visualizations and management cockpit.

The areas of data analysis, data mining, Big Data and Data Science intersect in a number of issues.

For example, **data analysis** is understood as the process of investigating, cleaning, transforming and modeling data to discover useful information, formulate conclusions and support decision-making. **Data mining**, on the other hand, is the process of extracting and discovering patterns in large data sets using methods at the interface between machine learning, statistics and database systems.

With the above assumptions, the path of development of competences in the field of visualization is as follows.

Level 1 – Basic (knowledge of basics)

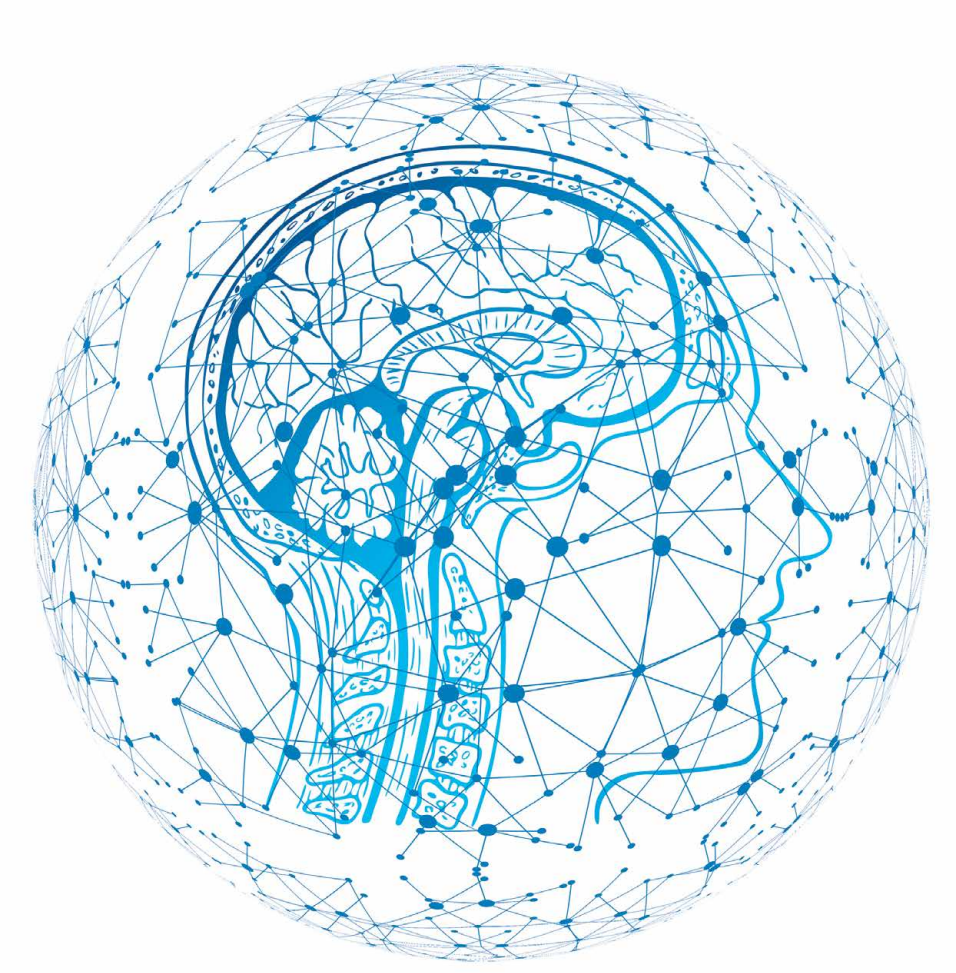
These are the competences necessary for the use of databases and visualization tools, defining important concepts and skills related to understanding selected concepts, e.g. databases, data warehouses and demonstrating competences for understanding data analysis and visualization.

Table 10. Learning achievements for cluster coordinators. Data visualization – basic level

	Knowledge
1	Recognizes data visualization techniques.
2	Recognizes data visualization tools (Power BI, Qlik Sense, Tableau).
3	Recognizes statistical methods for data analysis.
4	Discusses goals and functions of creating dashboards.
5	Defines Key Performance Indicators (KPIs) in the development of analysis systems.
	Skills
1	Visualizes data using spreadsheets and other tools (of similar class) to represent datasets in graphs.
2	Can use pivot tables and pivot charts to summarize datasets.

Source: own study.

Figure 8. Data analysis



Source: pixabay.com

Level 2 – Intermediate (outsourcing cooperation)

These are the competences necessary to understand how data is stored (database structure) and to perform typical tasks with the use of them. These competences are particularly important for those who deal with datasets and visualization tasks. The intermediate level includes an analysis of the definition of the database and how it is organized, as well as the ability to create and combine tables and filter, and to design queries for the purposes of forms and reports.

Table 11. Learning achievements for cluster coordinators. Data visualization – intermediate level

	Knowledge
1	Knows how to import data into a spreadsheet and how to prepare it for analysis by cleaning and filtering.
	Skills
1	Creates dashboards with ready-made components and modules (the so-called building blocks).
2	Discusses the main concepts for analyzing and visualizing data in business.
3	Can prepare data for statistical analysis, in particular: • can verify the reliability of the data collected; • assess the completeness of the data; • assess the representativeness of the sample in terms of "population parameters" and other selected parameters; • perform data pre-cleaning and coding.
4	Can apply statistical analysis concepts to datasets.

Source: own study.

Level 3 – Advanced (unassisted use)

These are the necessary competences for statistical analysis, dataset preparation, data summary and data visualization. They refer to the highest level of digital competences discussed in this sub-chapter. They may be extended with additional competences to use a specific tool.

Table 12. Learning achievements for cluster coordinators. Data visualization – advanced level

	Knowledge
1	Has knowledge of specific statistical functions and techniques that can be implemented using EDA (Exploratory Data Analysis) tools, i.e. in particular: 1. Grouping and size reduction techniques that help create graphical images of high-dimensional data with multiple variables. 2. Visualization of one variable for each field in the raw dataset with a statistical summary. 3. Visualization of two statistical variables and summaries that allow to assess relations between individual variables in a dataset and a target variable. 4. Visualization of two statistical variables and summaries that allow to assess relations between individual variables in a dataset and a target variable. 5. K-Mean grouping method. 6. Predictive models, such as linear regression, that allow statistics and data to be used to predict outcomes.
	Skills
1	Uses advanced statistical methods for data analysis (e.g. K-Mean grouping; predictive models such as linear regression).
2	Can perform ETL (Extract – Transform – Load) data processing in selected tools.
3	Can use basic EDA (Exploratory Data Analysis) tools.
4	Can perform selected data analysis, exploration and visualization tasks in Power BI, Qlik Sense, Tableau class tool.
5	Creates a dashboard itself using libraries and components and using simple programming language blocks, such as Python.

Source: own study.

4.3. Cluster troubleshooting by visualizing: examples

Valuable visualization tools should present a set of information supporting decision-making processes taking place both in member companies and in the coordinator's office as to the directions and scope of support of cluster entities.

Visualization tools can enable or improve the quality of the presentation of data on companies that are cluster members, such as the assessment of the financial situation of companies, the diagnosis and forecast of demand on domestic and foreign markets, planned reductions or downtimes in production, as well as barriers to development. It may also be a part of a compendium of knowledge on development trends in the cluster population and industry.

An example of good practice is a tool implemented in the Metal-Working Cluster called B-KOM – Economic Barometer. As cluster members are companies that participate in global value chains, they have quickly started to be affected by the crisis caused by the COVID-19 pandemic. The urgent need for information and an analytical approach to economic change has become a major concern. The cluster members expressed interest, for example, in information on the economic situation of the Metal-Working Cluster and the metal industry. Answers were also sought to various questions, such as whether this is a good time to invest, how to manage personnel in times of restrictions, how to monitor safety rules and how to take other actions[49].

The cyclical analysis of key indicators in B-KOM tool is a sort of economic barometer for the metal industry. The results of the study arouse great interest not only among cluster companies, but also among external entities, such as the Marshal's Office of the Podlaskie Voivodeship or the Ministry of Labor and Technology Development. As a result of the implementation of good practice, users of the Barometer gain knowledge about the economic situation and the functioning of companies, which allows them to make appropriate investment decisions or decisions concerning further actions of companies. The solution was awarded the PARP award under the category "100 best projects to increase the level of digitalization in the company". The Barometer was also recognized as an interesting tool for economic situation study in selected populations by the World Bank experts.

49 *Barometr KOM doceniony w konkursie Najwyższa Jakość [KOM barometer appreciated in the competition Highest Quality]*, Metal Processing Cluster, https://www.metalklaster.pl/news/barometr-kom-doceniony-w-konkursie-najwyzsza-jakosc

Table 13. Examples of the use of data visualization in cluster coordinator tasks

	Problem description	Method of realization	Tools	Benefits
Example 1	Communication of cluster own analyses in the form of a dashboard – input to reports or applications, e.g. to a group of Key National Clusters.	Collection of data by means of surveys among the cluster members and coordinators' data. Common data repository. Generation of reports as an input to reports or applications.	Management cockpits; Surveys of cluster members. RPA tools + low-code.	Improvement of data flow. Possibility to quickly update lists, visualize on cockpit and generate up-to-date reports. Possibility to compile year-to-year results or other historical data.
Example 2	Aggregation or additional analysis of industry economic factors relevant to the cluster members.	Software robot (RPA) supported by NLP algorithms. Scanner using API access to central registers. Website content scanner (webscraping) or using RSS.	Management cockpits. Reports. Sending e-mail newsletters.	Access in one place to key indicators from perspective of import/export and other activities in the industry in which the cluster operates.
Example 3	Use of visualized data on cluster members to promote the cluster during events and in social media.	Collection of data by means of surveys among the cluster members. Common data repository. Generation of graphics as an input to marketing or PR publications.	Management cockpits. Surveys of cluster members. Graphics generated based on data from the cluster information repository.	Support for cluster promotion activities. Faster and easier development of infographics, e.g. for online publications and social media.

Example 4	Assessment of the level of technology adoption (in particular Industry 4.0) by the cluster members.	Collection of data by means of surveys among the cluster members. Common data repository. Generation of graphics as an input to marketing or PR publications.	Management cockpits. Surveys of cluster members. Graphics generated based on data from the cluster information repository.	Support for cluster promotion activities. Use of statistics as an input to industry research or reports on cluster activities and innovation. Faster and easier development of infographics, e.g. for online publications and social media.
Example 5	Analysis of trends in the use of selected technologies (in particular Industry 4.0) in the sectors of the cluster members.	Software robot (RPA) supported by NLP algorithms. Website content scanner (webscraping) or using RSS.	Management cockpits. Graphics generated based on collected data.	Inspiration from analyses of data from the EU countries, the EU average and others. Possibility to analyze historical results.

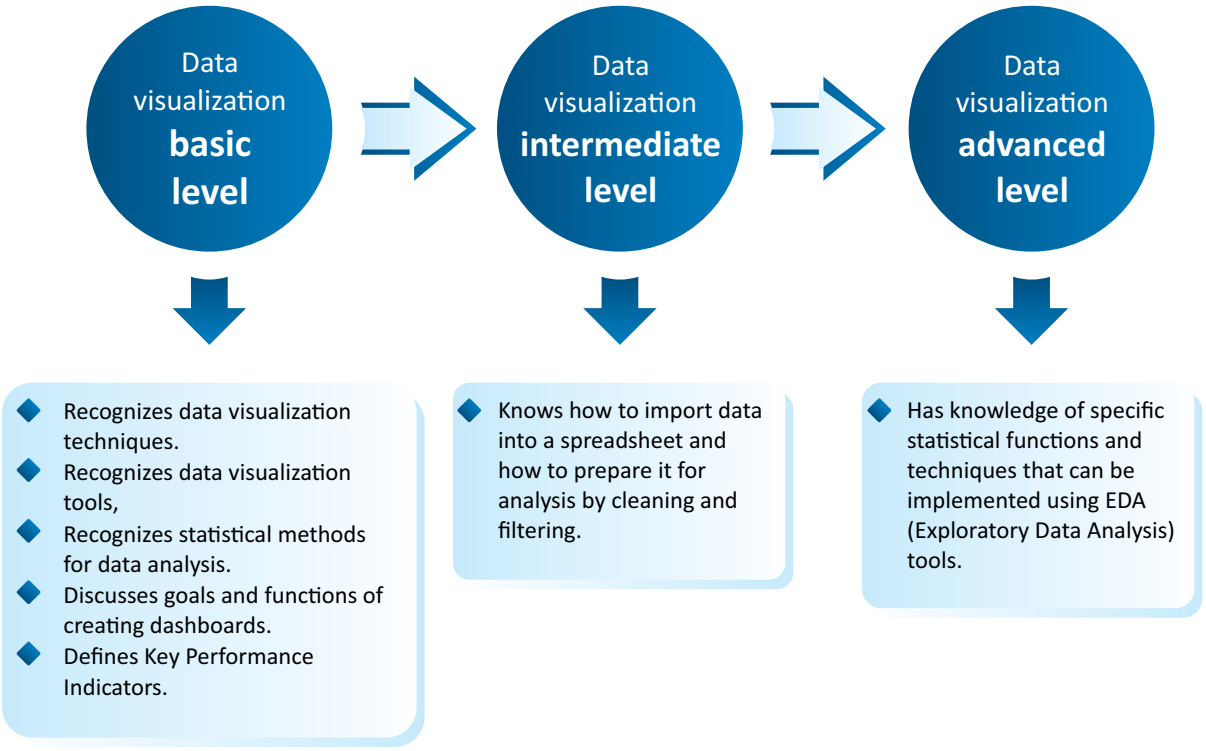
Source: own study based on workshops.

4.4. Paths to improve visualization literacy level

Digital competence regarding data visualization covers an unexpectedly wide range of skills needed. The value of visualizations is their usefulness as a tool to support business decision -making. Therefore, the selection of the scope of data on which it operates and the business models and their KPIs to which the visualizations refer requires great attention. In practice, this often means that visualizations are used either to assess the existing condition of selected business processes (descriptive analytics) or to support decision-making (diagnostic and predictive analytics).

Therefore, first of all, **data analysis and processing** literacy is crucial. Similarly to the Big Data/Data Science area, it seems that from the perspective of cluster coordinators, the most practical approach is to build data analysis and processing literacy (data analyst and date engineer – as in the example of the KNIME Learning Path[50]). This is a natural development of the data literacy competence which allows you to prepare valuable data for visualization.

Figure 9. The path of development of competences in the field of visualizations



Source: own study.

Another area is **Exploratory Data Analysis** (EDA) which helps to gain valuable knowledge from the data. EDA is used to analyze and study data sets and compile their main characteristics, often using data visualization methods. It also helps determine how best to use data sources to obtain the desired responses and facilitates pattern discovery, anomalies perception, hypothesis testing and assumption validation. EDA methods are primarily used to interpret data and also to help better understand variables in data sets and relations between

50 Rosaria Silipo, Schalk Gerber, Satoru Hayasaka, *Take Charge of Your Data Professional Journey,* KNIME, https://www.knime.com/blog/learning-paths-for-data-Professionals

them. Such methods also help to determine whether the statistical techniques planned to be used for data analysis are appropriate.

> An interesting approach to the competence development path for data analysis, visualization and Data Science is the (previously mentioned) material available on the website of the KNIME platform developers.

Given the proposed competence levels for cluster coordinators and the acquisition of specific knowledge and skills, development paths can be built in various ways, e.g. depending on the preferences of employees. The multitude of free and commercial courses on YouTube or educational platforms, e.g. Udemy, O'Reilly Online, Coursera, etc., offers quite wide options to improve competence. Commercial and open source vendors provide guides and courses that are directly related to their tools, such as UiPath, Microsoft Power Platform, KNIME, Power BI, Qlik Sense, Tableau. Below are some proposals where everyone should find something appropriate, regardless of the initial level of knowledge and skills.

Level 1 – basic (knowledge of bases)

Example materials:

1. Visual Data Exploration in Three Steps | KNIME, https://www.knime.com/blog/visual-data-exploration-in-three-steps
2. Data Visualization 101: 5 Easy Plots and Charts | KNIME, https://www.knime.com/blog/data-visualizaton-101-five-easy-plots-to-get-to-know-your-data
3. Beginner's Guide to Data & Data Analytics, by SF Data School | Udemy, https://www.udemy.com/course/learndata/
4. What Is Data Visualization? Definition & Examples | Tableau, https://www.tableau.com/learn/articles/data-visualization

Next steps:

1. Take Charge of Your Data Professional Journey | KNIME, https://www.knime.com/blog/learning-paths-for-data-professionals
2. Beginner's Guide to Data & Data Analytics, by SF Data School | Udemy, https://www.udemy.com/course/learndata/

Level 2 – Intermediate (outsourcing cooperation)

Example materials:

1. Visual Data Exploration in Three Steps | KNIME, https://www.knime.com/blog/visual-data-exploration-in-three-steps
2. Data Visualization 101: 5 Easy Plots and Charts | KNIME, https://www.knime.com/blog/data-visualizaton-101-five-easy-plots-to-get-to-know-your-data
3. Beginner's Guide to Data & Data Analytics, by SF Data School | Udemy, https://www.udemy.com/course/learndata/
4. Certificate in Qlik Sense Analytics Development | Udemy, https://www.udemy.com/course/is-my-startup-doing-ok/
5. The Complete Introduction to Data Analytics with Tableau | Udemy, https://www.udemy.com/course/the-complete-introduction-to-data-analytics-with-tableau/
6. Business intelligence: A complete overview | Tableau, https://www.tableau.com/learn/articles/business-intelligence
7. Digital Dashboard: Definition and 15 Key Examples, https://www.qlik.com/us/dashboard-examples/digital-dashboard

Next steps:

1. Take Charge of Your Data Professional Journey | KNIME, https://www.knime.com/blog/learning-paths-for-data-professionals
2. Certificate in Qlik Sense Analytics Development | Udemy, https://www.udemy.com/course/is-my-startup-doing-ok/

3. The Complete Introduction to Data Analytics with Tableau | Udemy, https://www.udemy.com/course/the-complete-introduction-to-data-analytics-with-tableau/

Level 3 – advanced (independent operation)

Example materials:

1. Visual Data Exploration in Three Steps | KNIME, https://www.knime.com/blog/visual-data-exploration-in-three-steps
2. Build an Interactive Data App in 3 Steps | KNIME, https://www.knime.com/blog/how-to-create-an-interactive-dashboard-in-three-steps-with-knime
3. Guided Visualization and Exploration | KNIME, https://www.knime.com/blog/guided-visualization-and-exploration
4. The Data Analyst Course: Complete Data Analyst Bootcamp 2022 | Udemy, https://www.udemy.com/course/the-data-analyst-course-complete-data-analyst-bootcamp/
5. Certificate in Qlik Sense Analytics Development | Udemy, https://www.udemy.com/course/is-my-startup-doing-ok/
6. The Complete Introduction to Data Analytics with Tableau | Udemy, https://www.udemy.com/course/the-complete-introduction-to-data-analytics-with-tableau/
7. Statistics & Mathematics for Data Science & Data Analytics | Udemy, https://www.udemy.com/course/statistics-for-data-science-data-analytics/

Next steps:

1. Know Your Data with Descriptive Statistics in KNIME | KNIME, https://www.knime.com/blog/know-your-data-descriptive-statistics
2. Take Charge of Your Data Professional Journey | KNIME, https://www.knime.com/blog/learning-paths-for-data-professionals
3. The Data Analyst Course: Complete Data Analyst Bootcamp 2022 | Udemy, https://www.udemy.com/course/the-data-analyst-course-complete-data-analyst-bootcamp/

CONCLUSIONS

Conclusions

Today, **digital competence** is very important, not only to be able to fully function in society. The European Parliament has identified it as one of the eight **key competences**, which are intended to ensure self-fulfillment and personal development. Such competence is therefore seen as equivalent to competences such as communication in the mother tongue, social and civic competences or cultural expression.

However, from the perspective of the economy, digital competence is a cornerstone for boosting the competitiveness of national businesses. The competence is to ensure an effective digital transformation in processes, products and business models that take advantage of the latest developments in automation, artificial intelligence, ICT, cybersecurity, or human -machine communication[51].

Clusters, in particular the **Key National Clusters**, are one of the most important recipients and stakeholders of the network economy. Through their activities, they contribute to the development of entrepreneurship and competitiveness of both their member companies and entire regions, and thus of the national economy.

The system for selecting Key National Clusters includes an assessment of five areas of cluster functioning, namely:

1. human, infrastructural and financial resources,
2. economic potential of the cluster,
3. creation and transfer of knowledge,
4. actions for public policies,
5. customer focus.

In this context, the digital competence also appears to be an important element. This Guide is intended as an attempt at involving cluster coordinators in the digitization of the economy through capacity building. The selection of programming, Big Data/Data Science and data

51 *Dz. U. 2019 poz. 229, ustawa z dnia 17 stycznia 2019 r. o Fundacji Platforma Przemysłu Przyszłości [Act of January 17, 2019 on the Future Industry Platform Foundation]*. Available at: https://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20190000229/T/D20190229L.pdf

visualization as competences included in this Guide was dictated precisely by the forecasts related to the fact that these competences will support the development of competitiveness of the Polish economy, while clusters may constitute important educational centers for developing these competences among Polish companies, regardless of the level of a given cluster or enterprise.

Digital transformation with the use of data offers new opportunities, even as far-reaching as changing the position of organizations in the value chain. This may be particularly relevant for clusters and their members, as digitization enables the transition from the position of an industrial product supplier to that of a service provider[52] on the market where the company has traditionally supplied its products as a final product.

Figure 10. Five areas of cluster functioning

Source: own study.

The analysis of the European Commission's initiatives and actions gives reasons to believe that dealing with the challenges faced by Polish key clusters will depend on many years of projects and initiatives. Clusters should start implementing actions that prepare them to engage in global value chains and EU mechanisms based on Big Data.

52 A service provider is understood to be a service provided using data collected by the systems, and then aggregated and processed in order to make the service available.

In practice, this means that in order to meet the requirements of the DATA Act[53] and AI Act[54], clusters will have to build new tools for data aggregation and analysis and APIs for data exchange with European systems. All in order to exchange data with platforms developed by the EU, as part of the "Digitizing European Industry" strategy, as well as value creation within global chains, e.g. in accordance with the "Common European Industrial IoT and Data Ecosystem" concept[55].

The aforementioned direction cannot be implemented without strong involvement of the coordinators of the Key National Clusters. The conclusions of the workshops with 10 representatives result in practical examples of the use of digital competence for cluster coordinators' offices. The list is presented below:

1. **Programming**

- reporting information on new competitions on grant websites and updates on these grant programs,
- issuing and sending member contribution invoices,
- media monitoring with regard to publications on the cluster and its members,
- sending automated queries for estimating the value of services,
- analysis of changes to corporate data of cluster members and up-to-date contact details.

2. **Big Data/Data Science**

- using information on cluster members from public registers (e.g. SUDOP),
- supporting the creation of sales groups in the logic of ad-hoc consortia,
- supporting the exchange of resources between cluster members,

53 *Data Act | Shaping Europe's digital future - a key measure for making more data available for use in line with EU rules and values*, European Commission, 2022. Available at: https://digital-strategy.ec.europa.eu/en/policies/data-act

54 *A European approach to artificial intelligence | Shaping Europe's digital future*, European Commission, 2022. Available at: https://digital-strategy.ec.europa.eu/en/policies/european-approach-artificial-intelligence

55 *Strengthening Strategic Value Chains for a future-ready EU Industry*, Report of the Forum for Important Projects of Common European Interest, 2018. Available at: https://ec.europa.eu/docsroom/documents/37825

- entering paper documents into IT systems,
- analysis of sentiment in publications on the cluster and its members.

3. Data visualization

- communication of cluster own analyses in the form of a dashboard as an element of reports or applications, e.g. to a group of Key National Clusters,
- aggregation (or additional analysis) of industry economic factors which are relevant to the cluster members,
- use of visualized data on cluster members to promote the cluster during events and in social media,
- assessment of the level of technology adoption (in particular Industry 4.0) by the cluster members,
- analysis of trends in the use of selected technologies (in particular Industry 4.0) in the sectors typical for the cluster members.

The application (Digital Competence Verifier) is a practical way to use the knowledge and experience gained during the project implementation. The verifier allows to assess the level of knowledge in the 3 digital competence areas under analysis, and then, after receiving the result and recommendation, to address one of the two development paths at the basic and intermediate levels. As assumed, the deliverables of the project, i.e. the Verifier together with the Guide, will be a compendium of knowledge and a source of inspiration for the development of digital competence of the employees of the cluster coordinators' offices in the future.

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The Future Industry Platform - a foundation established by the Ministry of Development and Technology to strengthen the competences and competitiveness of entities operating in Poland - entrepreneurs, cluster coordinators, entities operating for the innovative economy and social and economic partners in the field of digitization.

Verein Industrie 4.0 Österreich - die Plattform für Intelligente Produktion - a non-governmental organization focusing on the digital transformation of Austrian companies and research institutions in the field of production. Its aim is to support Austrian stakeholders in the development and application of digital tools and know-how.

Project No. 2021-1-PL01-KA210-VET-000034558 entitled „Digital competences of cluster coordinators" was implemented as part of Small-Scale Partnerships in the VET sector under the Erasmus+ Programme. The main objective of the project was to meet the common needs and priorities of the partners in terms of supporting the development of selected digital competences of cluster coordinators. The goal of the project was achieved by:

1. developing a COMPETENCE GUIDE together with stakeholders, containing a description of digital competences and defining appropriate development paths for cluster coordinators, which are necessary to implement the digital transformation of cluster value chains;

2. preparation of the COMPETENCE VERIFIER, i.e. an IT tool that allows you to self-assess your digital competences and define gaps in this respect in the context of implementing the digital transformation of cluster value chains.

See also:

https://weryfikatorkompetencji.przemyslprzyszłosci.gov.pl