Definition of an I4.0 maturity evaluation matrix

Thematic report

Lodz, September 2020

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Introduction

This report summarizes the analysis of the ways and possibilities of using digital maturity models to support entrepreneurs in transforming their businesses so that they can compete effectively in the market under the conditions of Industry 4.0. The report is to result in recommendations for Managing Authorities and Intermediate Bodies on the effective and efficient distribution of funds from relevant financing programs.

Methodology used:

- focus interview with representatives of various circles (representatives of the world of science, intermediary institutions, business representatives and technology transfer centers),
- analysis of scientific materials and business reports from various sources,
- analysis of materials from the INNO PROVEMENT project partners,
- analysis of selected digital maturity assessment tools,
- interviews with business representatives
- review of industry publications on the topic in Polish and English.

The report in the first part presents general information on the INNO PROVEMENT project and general information about the digital maturity of SME enterprises (with particular emphasis on companies from the Łódź region) as well as trends and future technologies that are likely to be implemented under Industry 4.0.

In the next part, the report presents selected best known examples of models examining digital maturity in the world and in Poland.

During the course of the study, much attention was paid to identifying the digital maturity tools of SMEs that are used in the INNO PROVEMENT partner countries. The result of the research is presented in the next chapter and it is preceded by a part containing an analysis of the possibility of using valuable elements from already existing solutions.

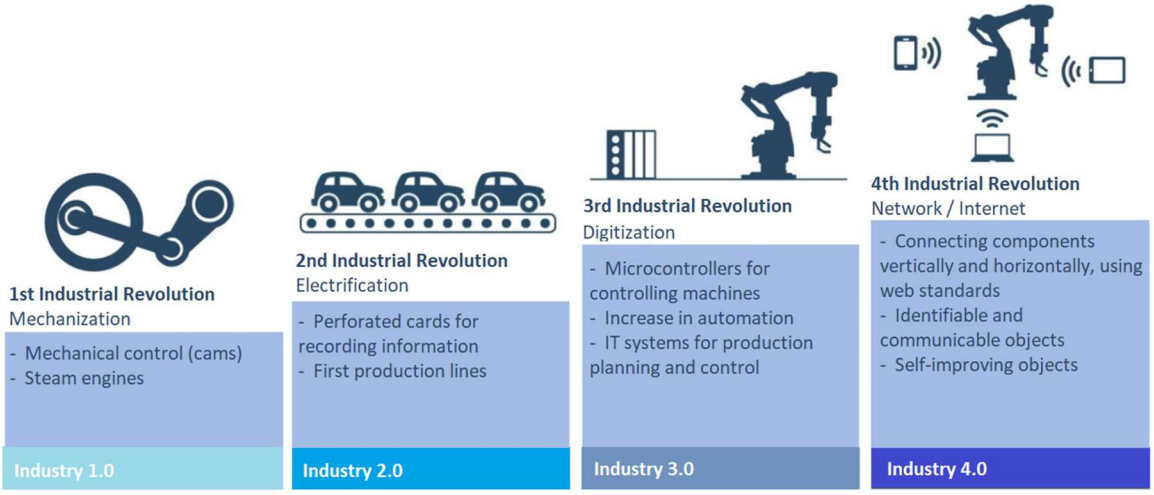
The collected analytical material was also supplemented with subjective opinions and recommendations of representatives of various circles. Their statements were collected during two moderated focus interviews.

The final part of the report contains a summary and recommendations for Managing Authorities and Intermediate Bodies on the effective support of SMEs through digital transformation in the context of Industry 4.0.

1.1 Information on the objectives of the INNO PROVEMENT project

Development is continuous. Evolution says you'll either adapt or you won't survive. Either you will be the leader of change or your life will change, even if you don't want to. Improving the methods of work and production brought an Industrial Revolution at the end of the 18th century, which mechanized work and moved industry by using steam drive. The second industrial revolution came about 100 years later. It started when the power source was changed from steam to electricity.

Figure 1 - graphical depiction of consecutive key changes in the industry



Source: Industrie 4.0 – smart devices will communicate with each other over the Internet and coordinate their activities, https://www.kierunekfarmacja.pl/artykul,27997,przemysl-4-0.html

It took less than 60-70 years for another revolution related to the popularization of computers, the increase in automation and the implementation of control systems to come. The next change took only 40-50 years. Currently, the world is in the beginning of the 4th industrial

revolution, which uses the collaboration of people, customers, systems, organizations and machines using boundless and incessant communication adopting the transmission and processing of huge amounts of data.

According to the industry web portal automatyka.pl, Industry 4.0 (Industry 4.0, German Industrie 4.0), i.e. the fourth industrial revolution is based on digital integration of production systems and the creation of autonomous, digitally controlled networks of machines and sensors that can communicate with each other, and to communicate with the people supervising their work.[1]

Industry 4.0 (i4.0) somehow forces innovative activities of companies in the world. Failure to modernize production or the method of providing services adapted to i4.0 will result in the loss of customers and markets, as customers around the world quickly adopt new technologies, are able to communicate better, are aware of their needs and the possibility of receiving products that meet their expectations better and better. .

The INNO PROVEMENT project was created to help small and medium-sized enterprises meet the new challenges that the new paradigm of Industry 4.0 imposes on them. Project partners' experience suggests that policy instruments targeting innovation in SMEs often face difficulties in successfully supporting i4.0 projects. Eight partners from five regions, working within the INNO PROVEMENT project, aim to improve instruments focused on innovative activities and adapting SMEs to the requirements specified in i4.0.

This overall objective will increase the participation and number of SMEs successfully implementing i4.0 innovation projects in partner regions and countries. Seven relevant thematic issues will be explored in depth through an intensive exchange of experiences. These topics are:

- Innovations in software development,
- Effectiveness of public funds used to support research and development in industry under i4.0,
- Introducing i4.0 to traditional industries,
- I4.0 definition of public policy initiatives,

1 M. Bieńkowski, Przemysł 4.0 - a challenge for the future, https://automatykaonline.pl/Artykuly/Przemysl-4.0/Przemysl-4.0-wyzwanie-na-przyszlosc, [accessed: 07/18/2020]

- Adjusting tenders to i4.0 requirements,
- Market price assessment methodologies,
- Definition of the maturity assessment matrix i4.0.

To sum up, the concept of Industry 4.0 makes it possible to use the automation and digitization processes that have been taking place in industry for years. This idea encourages the transformation of factories into self-controlling and self-organizing systems, connected and being part of transnational networks integrating value chains.

1.2 Characteristics of the digital maturity of Polish enterprises, with particular emphasis on enterprises from the Lodz voivodeship

The company's digital maturity is a concept that describes the company's readiness to operate in a digitized world, and thus to constant two-way communication with business partners and customers. It is also the ability to obtain and process a huge amount of information from partners, customers and automatic data sources. Crucially, high-level digital maturity not only means efficient data acquisition and processing. It also means, among others ability to react quickly and flexibly adapt the processes of generating the value stream.

One of the most interesting descriptions of what digital maturity is was placed on a web portal specializing in promoting Industry 4.0. “Digital maturity is a multidimensional concept that requires development in many areas relating both to the company's technological resources, but above all to management methods, organizational culture and changing the perception of the role of your company in network value creation. Mature organizations are characterized by the ability to introduce new business models, a customer-centric approach, and flexible adaptation to changing market trends. "[2]

For the purposes of this analysis, it has been assumed that digital maturity is the company's ability to use modern and advanced technologies by conscious, constantly learning employees operating in an organization that has adapted its processes and business models to

2 Z. Piątek, What is digital maturity?, https://przemysl-40.pl/index.php/2018/06/11/dojrzalosc-cyfrowa/, [accessed: 17/07/2020]

quickly and optimally respond to the acquired data on customer requirements in in order to increase the competitive advantages and market share. Thus, digital maturity combines the organizational, human (in most of the cited studies included in the organizational dimension) and technological dimensions.

Digital maturity is a concept that is entering the minds of entrepreneurs just now. The authors of the study "Digital Maturity Models for Small and Medium-sized Enterprises: A Systematic Literature Review" repeatedly raise the problem of the lack of knowledge about it among entrepreneurs. Without specialist knowledge on the subject, which is often absent from company resources, it is difficult to properly assess the current and, more importantly, future requirements for digital transformation.[3]

Digital maturity includes the ability to implement and use modern technological solutions. In the further part of this report, more detailed data for selected technologies are presented in relation to the Lodz Voivodeship, at this stage it is worth indicating the general level of digital competences for Poland. According to the DELab UW research center, every twentieth Polish SME company uses cloud computing services, which is over four times less than in the EU countries. Two times less Polish enterprises sell online than companies in other EU countries. When asked about the reasons why SMEs choose not to use cloud computing, the highest percentage was reported by the answer "insufficient knowledge", over 40% of respondents.[4]

According to a study by scientists from the DELab UW research center, the highest level of maturity means:

- full use of digital technologies to achieve, inter alia, data integration in the value chain,
- maximizing the business benefits of customizing business models,
- implementation of digital technologies in the field of production and personalization of products,

3 C. Williams, D. Schallmo, K. Lang, L. Boardman, Neu-Ulm „Digital Maturity Models for Small and Medium-sized Enterprises: A Systematic Literature Review", University of Applied Sciences, presented on conference IPSIM Innovation Conference held in Florence in Italy, 16-19 July 2019

4 K. Śledziewska, R. Włoch „Digitaj competencies of small and medium enterprises", DELab University of Warsaw, 2015

- building competences within the digital ecosystem,
- effective management and development of employees' skills.

Digital maturity means the ability to adapt to the conditions of Industry 4.0. This in turn will create completely new requirements in meeting the needs of customers, partners and own production centers, often geographically dispersed. The new market requirements will reduce the attractiveness of the offer of companies whose adaptability to Industry 4.0 conditions will be low and which will not be able to compete with more advanced organizations.

Increasing the competitiveness of Polish entrepreneurs is the main goal of The Future Industry Platform Foundation established by the Parliament on 17 January 2019 under the Act. Its purpose is to support the digital transformation of enterprises, i.e. disseminate knowledge about robotics, artificial intelligence, cloud computing, the Internet of Things (IoT), 3D printing, 5G standard, the use of drones and other solutions falling within the concept of Industry 4.0

The digital maturity of an enterprise is determined not only by having digital technologies, but also by how the company designs and offers its products, how it works with customers and business partners, how it manages data, to what extent it applies autonomous solutions and systems, or how it collaborates between partners.[5]

The concept of digital maturity, as we have already indicated, also includes the human factor, as effective implementation of any change requires appropriate competences at various levels of management in the enterprise. Adequate care for the appropriate competences of human capital in companies seems to be crucial. This fact is particularly clearly visible in comparison with the results of the diagnosis of digital competences in Poland, carried out by scientists from the Warsaw School of Economics. They write: "The low level of digital skills of human capital is the main reason for the low level of digitization of Polish SMEs, which may harm their development in the context of the digital single market in the EU."[6]

5 Digital Maturity 2018 - Digital Maturity Report, https://zrobotyzowany.pl/informacje/publikacje/3048/dojrzalosc-cyfrowa-2018-raport-digital-maturity, [accessed: 20/07/2020]

6 K. Śledziewska, R. Gabryelczyk, R. Włoch, 2017. " Measurement of digital competences - diagnosis for Poland" Annals the Collegium of Economic Analysis, Warsaw School of Economics, Collegium of Economic Analysis, 45th edition.

Based on the document: Regional Innovation Strategy for the Lodzkie Voivodeship "LORIS 2030", it should be assumed that there are several specific types of activities that bring special value to the economic life of the voivodeship. Six specializations are of key importance for the Lodz region:

- modern textile and fashion industry (including design),
- advanced building materials,
- medicine, pharmacy, cosmetics,
- energy, including renewable energy sources,
- innovative agriculture and agri-food processing,
- IT and telecommunications.

The "LORIS 2030" strategy indicates companies from various industries that are often not associated with data processing as recipients of activities transforming to Industry 4.0.

Digital maturity or transformation in Polish enterprises is understood differently. According to the Computerworld report, as many as 75% of companies from the Industry/Production/Mining sector most often indicated the implementation of new IT tools as a way of fulfilling digital transformation in their organizations. 26.3% of the respondents indicated the improvement of process flexibility and efficiency as the expected greatest business benefit. Other arguments among the responders were indicated as follows: cost optimization, effective decision making based on previously unavailable data, increasing the attractiveness of the work environment and acquiring new customers. It should be noted that the Computerwold report focuses mainly on IT support of processes, ignoring the human aspect and organizational culture, which plays a significant role in digital maturity.

More comprehensive research shows that one of the most important challenges for enterprises is the competency gap in the area of specialist skills related to new technologies. The respondents indicated that their enterprises lack adequately qualified teams (63% in the world and 69% in Poland), especially in the areas of cybersecurity, data protection and data analytics. Furthermore, they predict that this gap will widen in the future (38% in Poland and 39% in the world). Moreover, almost ¾ of enterprises allocate no more than 5% of the budget to investments in digital technologies. The same study found that the main obstacles to achieving a return on

investment in digital technologies are: lack of support within the organization (31%), lack of qualified teams (31%) and inflexible or too slow processes (29%).[7]

The need for complex changes transforming organizations to Industry 4.0 was also indicated by Jadwiga Emilewicz, the Minister of Entrepreneurship and Technology, who said: "Transformation to Industry 4.0 is a long-term process that requires changes on many levels. It is necessary to have an appropriate strategy, acquire new competences, train staff and finally implement selected solutions to a given company".[8]

According to the aforementioned PWC survey, only 44% of Polish respondents consider their company to be digitally mature, and 69% see a growing competency gap and the lack of adequately qualified teams. Although for 49% of respondents, investment in digital aims to increase revenues, these expenses do not exceed 5% of the annual budget of the organization, according to the quoted report. Emerging technologies are gaining in importance, which is why the Internet of Things, artificial intelligence and robotics are among the investment priorities.

Industry 4.0 is a new concept, its beginnings date back to 2011 in the German economy. Reports of international consulting companies found in the course of the analysis present the concept of digital maturity in a global perspective, hence it is difficult to find information about its level in relation to the Lodz Province. Therefore, it seems reasonable to rely on the statistical data of the Central Statistical Office of Poland presenting selected elements of digital maturity. Information on the use of the Internet in companies, 3D printing, methods and the dissemination of the use of the so-called clouds were adopted to attempt the assessment of the discussed phenomenon within the Lodz Province.

According to the data of the Central Statistical Office, out of 6,566 companies registered in the Lodzkie Voivodeship, 4.1% communicate very poorly with the market, and do not have a website at all. Others use it for various purposes, mostly to present the offer, recruit or promote their profiles on social networks. Total of 15.4% of the surveyed companies own websites that

7 Digital Maturity 2018 - Digital Maturity Report, https://zrobotyzowany.pl/informacje/publikacje/3048/dojrzalosc-cyfrowa-2018-raport-digital-maturity, [accessed: 20/07/2020]
8 Statement of the Polish Press Agency, date of publication: 24/07/2019

enable two-way business communication, i.e. allow you to control the status of an order or order products by their own specification.

Out of all the companies, 1,058 use cloud services and represents 16.1% of the respondents. Digital maturity includes the ability and use of the so-called cloud, using 3D printing or robots. These categories are examined by the Central Statistical Office. The tables below indicate the percentage of companies from the Lodzkie Voivodeship and the reference of this size to other voivodeships.

Table 1 – way of using the cloud by enterprises from Lodzkie Voivodeship

The service that the company uses in the cloud	Percentage of companies	Position of the measure among other voivodeships
e-mail	12,9%	3.
enterprise database hosting	6,4%	5.
file storage	8,7%	5.
CRM class software	3,1%	7.
computing power needed to support applications running in the company	2,5%	4.

Source: own study based on selected data from the Central Statistical Office for 2019

As the table shows, when analysing the use of the so-called Cloud of companies from the Lodz Voivodeship look quite good in relation to companies from other voivodeships.

Table 2 – use of selected new technologies among companies from Lodzkie Voivodeship

The use of modern technologies	Percentage of companies	Position of the measure among other voivodeships
Enterprises that use 3D printing in their activities	3,3%	8.
Enterprises using robots	6,3%	14.

Source: own study based on selected data from the Central Statistical Office for 2019

Based on Table 2, it can be concluded that enterprises from the Lodzkie Voivodeship have a lot to make up for, e.g. in terms of the use of robots, compared to companies from other regions of Poland.

The discussed issues related to Industry 4.0 require an innovative approach to activities. Therefore, it is important for the entire analysis to indicate that the document "Regional Innovation Strategy for the Lodzkie Voivodeship - LORIS 2030" quoted above states that the Lodzkie Voivodeship is a weak innovator at an average level.[9] This claim is confirmed, inter alia, by indicator prepared by the European Union and available within the Regional Innovation Scoreboard, according to which the Lodzkie Voivodeship represents a moderate level of innovation, the second one on a four-level scale. By comparison, the same level is represented by every region of Italy, most regions of Spain and regions in Greece.

9 Regional Innovation Strategy for Lodzkie Voivodeship - "LORIS 2030", Deloitte BC and ŁARR S.A., https://rpo.lodzkie.pl/images/prawo-i-dokumenty/RSILORIS2030final1.pdf

One of the important aspects of Industry 4.0 is innovation and the integration of communication between partners in the value chain. Thus, when looking at the value of the index in the category of "innovative SMEs cooperating with other SMEs", which in 2019 was 28.3 points (on a scale of up to 200 points), which puts the Łódź Voivodeship in 12th place among all voivodeships, it can be concluded that it is one from areas where action can bring about significant improvement.[10] Apart from the mentioned area, other areas showed by the indicator will also be important, i.a.: lifelong learning, innovators in the field of products and processes, own innovations created in SMEs. Overall, the Lodzkie Voivodeship takes the 11th position with the result of 92.09, while the leader is the Greater Poland Voivodeship with the index at the level of 157.05.

Based on the above information and indicators, it should be concluded that the level of digital maturity of enterprises in the Lodzkie Voivodeship shows a great growth potential. A lot of hope can be associated with companies in regional specializations, such as pharmaceuticals, energy, IT and telecommunications, as companies from these industries are usually the fastest to implement technological innovations.

1.3 The most popular technologies in the area of Industry 4.0 implemented in Polish companies.

Among the digital technologies that support Industry 4.0, Polish companies have opened up very much to the implementation of Business Intelligence (BI) solutions and analytical solutions. Regardless of the scope of the company's activity, each one processes data. The search and implementation of solutions supporting effective data processing and obtaining appropriate management information from them is currently a noticeable trend. ~~This phenomenon was confirmed by a representative of the Digital Innovation Hub in a private opinion during an interview.~~

10 *Regional Innovation Scoreboard 2019,* https://ec.europa.eu/growth/industry/policy/innovation/regional_en, [accessed: 21.07.2020]

Referring to market research, during the last 12 months, Polish enterprises (26.6% of respondents) invested in these aforementioned systems, and this trend will strengthen next year. The percentage is expected to increase by 31.5% with a significant decrease in planned investments in ERP systems (from 23.4% in the previous year to 14.4% in the coming year). A significant shift in investment resources can be expected by employees in areas such as robotization (12.7%) and production management systems (also 12.7%). CRM systems and electronic document circulation systems are not investment priorities according to the cited study.[11]

The attractiveness of the most popular technologies depends on the industry and the degree of development of the company. However, the publications show that due to their flexibility and multiplicity of applications, the following are very popular:

- cloud data processing,
- BigData and related analytics,
- deeper integration of IT systems.

For manufacturing companies, 3D printing technologies are certainly popular as they accelerate the modeling of new products, thus shortening the time of introducing the product to the market. Simulations and augmented/virtual reality are also gaining popularity, as a way to reduce training costs, test and implementation time, among others. The popularity of the technology is a derivative of the assessment of the chances to increase the attractiveness of the offer and the competitiveness of operations.

In addition to the above, the following are also growing in popularity:

- artificial intelligence - a set of technologies that allow machines to learn and solve complex problems,
- IoT (Internet of Things) - a phenomenon describing the use of the Internet for communication between products and the manufacturer's company, or companies that provide services using these clearly identifiable items,

11 Digital maturity of Polish enterprises - Computerworld and IFS research, https://www.computerworld.pl/news/Dojrzalosc-cyfrowa-polskich-przedsiebiorstw-badanie-Computerworld-i-IFS,417468.html, [accessed: 22/07/2020]

- collaborative robots - new generation robots that can cooperate with people without protective fences, these robots are also to be intuitive to use,
- mobile robots (AGV - automated guided vehicles) - autonomous vehicles supporting plant intralogistics,
- RFID - enables communication with production management systems and warehouse systems, what is more, it enables the creation of intelligent products that communicate directly with machines,
- blockchain - a technology that allows you to store information about transactions in distributed registers, will enable communication between entities without the need for a third guaranteeing company or institution.[12]

Many of the described technologies have existed for years and have found practical application, although they may not be widespread in Poland. The dissemination of knowledge about concepts, solutions and examples of successful implementation in the context of Industry 4.0 are key issues at the current stage of maturity of Polish enterprises.

Bearing in mind the above, and in the long term, the increase in the competitiveness of enterprises, the Future Industry Platform Foundation was established by the Parliament by the Act of January 17, 2019.

The Foundation is to act to increase the competitiveness of entrepreneurs and their development towards Industry 4.0. This is understood as, inter alia, supporting their digital transformation in the field of processes, products and business models using the latest achievements in the field of automation, artificial intelligence, teleinformation technologies and communication between machines and between humans and machines. Its task is to familiarize entrepreneurs with the subject of industry 4.0, as well as proposing business solutions, strategic consulting, building cooperative networks, or taking care of the legal and regulatory environment. This is to constitute an impulse to raise the level of technological advancement of Polish

12 Three trends for 2019 that will change the philosophy of production, management and energy consumption, https://automatykaonline.pl/en/News/Trzy-trendy-na-2019-rok-ktore-zmienia-filosophie-produkcji-zarzadzanie-i- zuzycie-energy, [accessed: 22/07/2020]

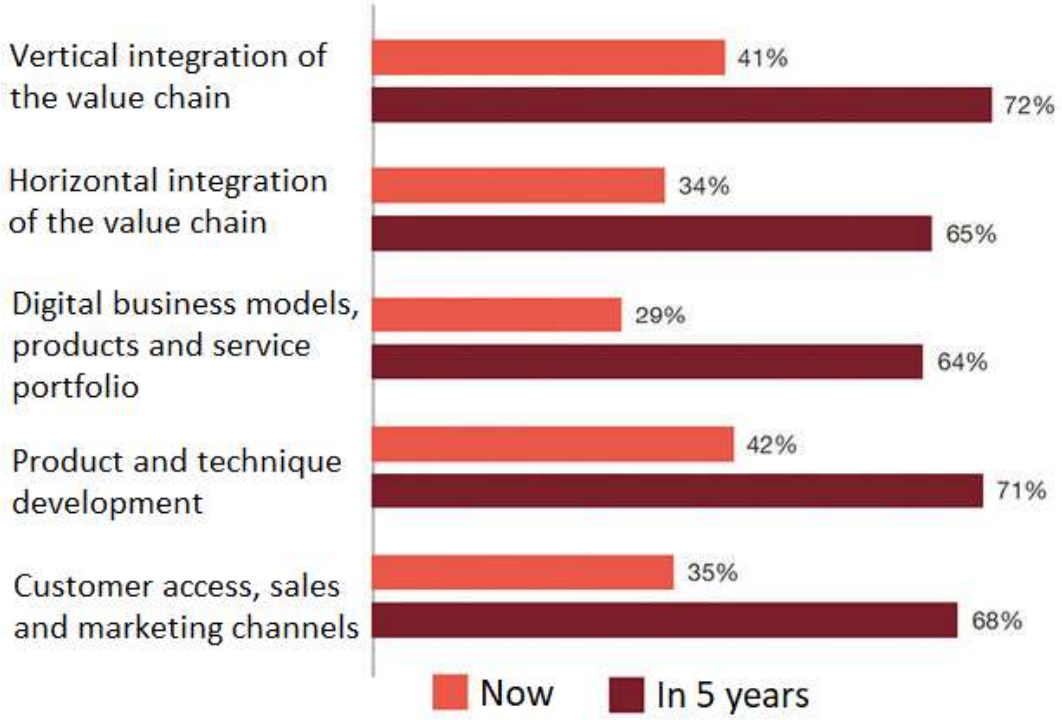
enterprises. The help offered by the Foundation is to meet the individual needs of a given enterprise.

Among the foundation's goals is also to help companies increase their productivity and competitiveness. For this purpose, trainings on the latest technological trends will be organized by the Foundation's experts. The Foundation will also offer the opportunity to test various solutions and consult with experienced experts in order to give companies a chance for an effective transformation towards industry 4.0.[13]

The survey conducted by the editors of Automatykonline.pl shows that the percentage of companies that can boast of digitized and integrated digital business models, products and service portfolios will more than double in the next five years.[14] At least two-thirds of companies are perceived to be highly digitized and integrated within five years. More research results are presented in the graphic below.

13 Own study based on information from the Ministry of Development of the Republic of Poland
14 M. Bieńkowski, op.cit.

Figure 2 - percentage of surveyed companies with a high degree of digitization and integration



Source: Industry 4.0 – a challenge for the future, https://automatykaonline.pl/Artykuly/Przemysl-4.0/Przemysl-4.0-wyzwanie-na-przyszlosc

During the focus interview, participants representing scientific institutions indicated, based on their experiences from conversations with business representatives and their own observations, that solutions based on data processing (BigData, Business Intelligence, analytics and forecasting, data processing in clouds) are becoming more and more popular. Consequently, the issues of cybersecurity and solutions in this field are becoming equally important. In terms of interest in additive printing and devices for 3D printing, according to the respondents, the interest is declining, and the technologies related to the business use of virtual and augmented reality are just waiting for increased interest. The fields of application for additive printing or VR/AR solutions are much more limited than for data processing, hence data processing will affect the largest number of companies, regardless of their size. University employees expect the largest

investments in this area. This applies to investments in infrastructure as well as in the development of human resources.

Bearing in mind that the global economy is a system of connected vessels and Industry 4.0 will increase the need for extensive communication even more, it is worth to become acquainted with the predictions about the upcoming technologies of the future. According to a study prepared for the World Economic Forum in 2018, the future of industry will need to significantly develop 12 key technologies. This consists of:

1. artificial intelligence and robotics,
2. ubiquitous connected sensors, also known as IoT (internet of thing)
3. augmented and virtual reality,
4. additive manufacturing (also includes 3D bio-printing of organic tissues),
5. blockchain and distributed record technologies,
6. advanced materials and nanomaterials (allowing to obtain favorable material properties, such as thermoelectric efficiency, shape retention and/or new functionalities),
7. energy acquisition, storage and transmission,
8. new processing technologies,
9. biotechnologies (including synthetic biology),
10. geoengineering (understood as a technological intervention to mitigate the effects of climate change by removing carbon dioxide or managing solar radiation),
11. neurotechnologies,
12. space technologies (allowing greater access and exploration of space; the term includes microsatellites, advanced telescopes, reusable rockets and integrated rocket engines)[15].

Referring to the six specializations of the Lodzkie Voivodeship listed in the "LORIS 2030" strategy, it can be assumed that the chances of its success will increase as much as companies from the region will be able to integrate digitally and communicatively with clients operating on the above-mentioned technologies.

15 *Readiness for Future of Production Report 2018*, World Economic Forum, http://reports.weforum.org/country-readiness-for-future-of-production/?doing_wp_cron=1595845437.6145279407501220703125

1.4 Forecast for the development of Polish companies towards the fourth industrial revolution

The study conducted at the request of PSI Polska Sp. z o.o. in the first quarter of 2019, among production companies shows, that among companies employing more than 250 employees, the most important are advanced ICT systems for production (70%), cooperation between people and robots (45%) and data analytics (32%). In smaller production companies, 50-249 employees, the most important thing is the cooperation of people and robots (60%), and only 43% of respondents noted advanced IT systems for production.[16] It can be seen, therefore, that investments in the development of IT systems will lead the way.

It should be remembered that people are responsible for implementing modern technologies, reorganizing business processes, and programming machines and activities based on the conclusions drawn. The results of the study published by the Ministry of Entrepreneurship and Technology in cooperation with Siemens Poland show that the key competences of Industry 4.0 engineers are technical (93%), personal (89%) and social (81%). Polish companies will develop towards Industry 4.0 as long as people working in production, who can configure advanced systems and react appropriately in contact with modern technology, will develop. In addition, the same engineers must be creative, innovative, constantly learn and be able to cooperate, lead and also build a network, but of business contacts.[17] These results clearly show what types of competences must be developed among the staff of production companies and in which training these companies should invest together with the development of the technological part of the machine park and organization of processes. The respondents of the quoted survey also pointed to the development barrier which is the lack of adequately educated staff. Over 50% of the respondents considered the current education system as not adjusted to the expectations and requirements of an innovative industry.

The results of the study "On the way to Economy 4.0", conducted by Computerworld in cooperation with IBM Polska, TIDK and ABB, reveal a rather painful truth. While companies, due

16 Report on Readiness of manufacturing companies to implement Industry 4.0 solutions, PSI Polska
17 *Smart Industry Poland 2019*, Siemens in cooperation with Ministry of Entrepreneurship and Technology, Warsaw, May 2019

to the transformation to Industry 4.0, expect an increase in efficiency or productivity (70%) and cost reduction (59%), and 25% indicate an improvement in the quality of products and services, as many as 75% of companies does not plan to act strategically in this direction.

When asked "**Has your company developed a strategic Industry 4.0 transformation plan at the corporate level?**" the following responses gave the following results.

Survey results on the validation of activities carried out as part of Industry 4.0 at the level of the strategic transformation plan.	**Percentage of the surveyed companies**
Yes, we have started implementing the Strategic Transformation Plan for Industry 4.0	14%
Yes, but we haven't started the implementation	0%
No, but we are preparing such a plan in 2019	11%
We do not have a strategic plan, but we implement smaller projects related to Industry 4.0	29%

No, we will not prepare a strategic plan but implement smaller projects related to Industry 4.0	19%
No, we are not planning any activities related to Industry 4.0	27%

Source: On the way to the economy 4.0, https://www.computerworld.pl/news/W-drodze-ku-Gospodarce-4-0-Wyniki-badania-Computerworlda,412715.html

The survey was conducted on 108 respondents from companies operating on the Polish market. SMEs accounted for 48% of the total number of respondents, the remaining group were companies with over 250 employees. The industry, production and mining sectors were the largest group (40%).[18]

By analyzing this data, one can come to the ~~sad~~ belief that Industry 4.0 is still a fashion statement for companies, meaning wishful thinking. If they are implemented, innovative projects are created almost from the bottom up without looking at the company's competitiveness in the long term. Many studies talk a lot about advanced technologies, however, it can be seen that there is a lack of a strategic approach to implementing changes and the appropriate, educated staff.

Answering the question about the forecast for the development of Polish companies based on the above research, it should be noted with concern that the development will mainly concern the improvement of selected processes and investing in technological innovations, the effectiveness of which the companies will not be able to measure.

2. Review of digital maturity models

In order for enterprises to effectively transform and efficiently compete in the conditions created by Industry 4.0, they need digital maturity. As the notion Industry 4.0 is quite an

[18] Ibid.

ephemeral name for a certain phenomenon, a notion without one recognized definition, digital maturity is likewise characterized by relative subjectivity and missing unambiguity. The authors of the Polish prototype digital maturity assessment tool for manufacturing enterprises propose to understand it as the ability of the organization to build an effective business strategy and acquire competitive advantage through the use of digital solutions.

In 2011, when the term Industry 4.0 was still not widely popular, researchers and business practitioners were talking about the so-called smart manufacturing, which, in the assumptions, at that stage, corresponded to the present concept of the new notion. As the researchers argue on what maturity really is and how to define it, most of them agree that maturity implies progress, development, from the initial state to a state defined as desired, optimal. In the early phase of development of i4.0 concept, several maturity assessment models were created for use in Industry 4.0. Some of the models, SMSRL (Smart Manufacturing Readiness Level), only assessed the manufacturing company's readiness for implementing data-based technologies for efficiency growth. Other ones, such as MOM (Manufacturing Operations Management), were supposed to evaluate mainly the level of the organization's ability to implement mature, efficient and repeatable production operations.[19]

Published in 2016 by publishing house Elsevier, the paper "A maturity model for assessing Industry 4.0 readiness and maturity of manufacturing enterprises" the authors of which are A. Schumacher, S. Erol, W. Sihn names five existing models. This information may be considered verified, because Elsevier is one of the largest scientific publishing houses worldwide and a company with a rich, over 100-year long tradition in analysis and provision of scientific data and information. The models recognized at that time are presented in the table below. A reference is made to the first of the mentioned models, IMPULS, among others, by the authors of the Portuguese tool for digital maturity assessment discussed in the further part of the report.

19 A. DeCarolis, M. Macchini, B. Kulvatunyou, M. Brundage, S. Terzi, Maturity models and tools for enabling Smart Manufacturing Systems: comparison and reflections for future developments, IFIP 14th International Conference on Product Lifecycle Management, Sevilla Spain, 10.07.2017

Table 3 – models of maturity and readiness for Industry 4.0 existing until 2016

Model name	*Institution/Source*	*Approach to assessment*
IMPULS – Industrie 4.0 Readiness (2015)	*VDMA, RWTH Aachen, IW Consult*	*The model evaluates, on 5 levels, 6 dimensions consisting of 18 elements; defines development barriers as well as advises how overcome them. Further in the analysis, this model is called a couple of times.*
Empowered and Implementation Strategy for Industry 4.0 (2016)	*Lanza and other authors*	*Fast Industry 4.0 maturity assessment by means of a checklist and as part of a model of processes for implementation; there are analyses of gaps and a set of tools for overcoming maturity barriers; there are no details concerning the subjects and the development process of*
Industry 4.0 /Digital Operation Sel Assessment (2016)	*PriceWaterhouseCoopers (at present PWC)*	*Tool available online, assessing in 6 dimensions; determines maturity using 4 levels; commercially used as a consulting tool; no information on the details and the change implementation process*
The Connected Enterprise Maturity Model (2014)	*Rockwell Automation*	*Maturity model as part of a five-stage approach to the implementation of Industry 4.0; assessment focused on technology in 4 dimensions; there are no details about the offered products and the development process (technical study)*
I 4.0 Reifegradmodell (2015)	*FH - Oberosterreich*	*Maturity assessment in 3 dimensions including 13 maturity indicators; maturity is evaluated on 10 levels; there are no*

		details concerning the offered products and the development process (the development process is not completed)

Source: "A maturity model for assessing Industry 4.0 readiness and maturity of manufacturing enterprises", A. Schumacher, S. Erol, W. Sihn, Elsevier. 2016, https://publik.tuwien.ac.at/files/publik_255445.pdf

J. Ganzarain and N. Errasti, the authors of the article "Three Stage Maturity Model in SME's towards Industry 4.0" stated that the company's maturity can be assessed on 5 levels. Here is the proposed way of assessing maturity indicating five digital maturity levels in companies:[20]

1. Level 1. Initial – the company does not have any specific vision determining its special nature within Industry 4.0
2. Level 2. Organization – An action plan is in place in order to build the Industry 4.0 strategy for the company.
3. Level 3. Definition – the company's customer segments, market offer and key resources are defined,
4. Level 4. Transformation – strategy transformed into specific projects,
5. Level 5. Definition of business models – transformation of business models.

In the quoted study of scientists from the Polytechnic University of Milan, special attention should be paid to the DREAMY model (Digital REadinessAssessmentMaturitY model). This model combines two purposes: evaluates the manufacturing company's level in terms of starting the digital transformation process and identifies the company's strengths and weaknesses, and the related opportunities. The model also takes account of the product life cycle and the business life cycle. The use of the DREAMY model involves a high investment of time. Its correct use requires two days devoted to a visit in the factory and one day for workshops, in the course of which feedback and brainstorming sessions are conducted. Anna De Carolis from the Polytechnic

20 J. Ganzarain, N. Errasti, Three Stage Maturity Model in SME's towards Industry 4.0, Journal of Industrial Engineering and Management, October 2016

University of Milan, one of the authors of the above quoted study, assures that the model works successfully in Italian and German enterprises.

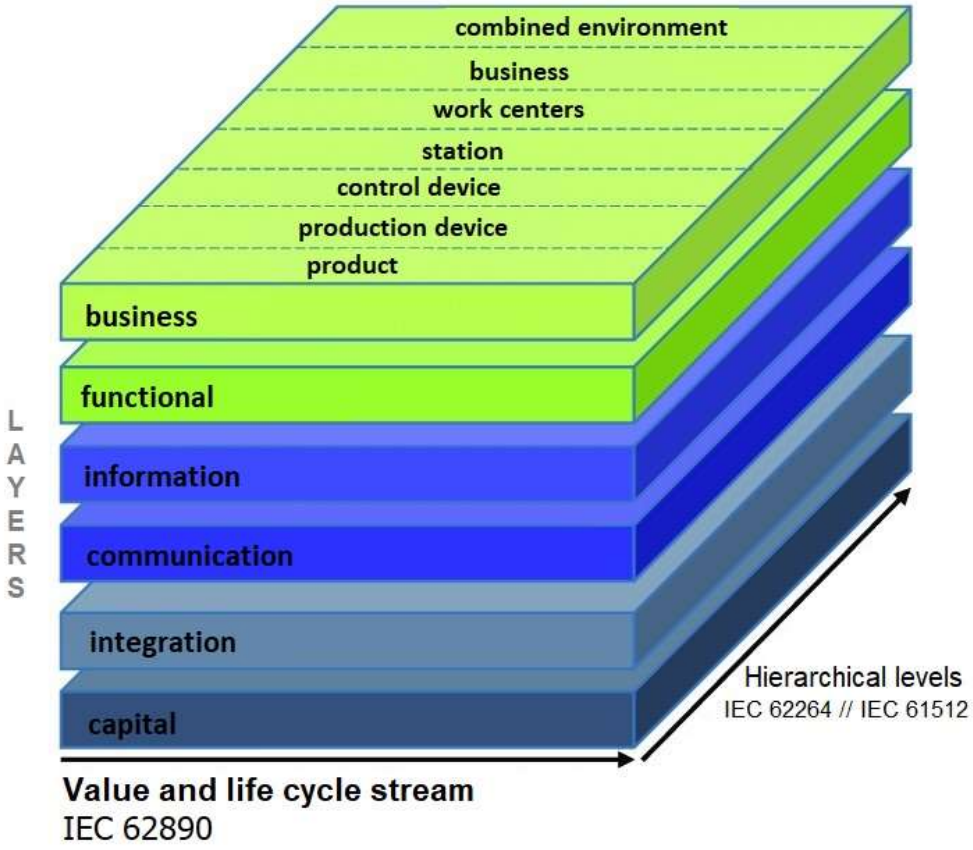
For the needs of a faster diagnosis and in order to disseminate the digital transformation idea, the Polytechnic University of Milan has developed a new business self-assessment tool. The questionnaire can be filled in independently, support on the part of DIH (Digital Innovation Hubs) is also recommended. The study is available at https://www.teleindustria4-0.com, the estimated time necessary to complete the questionnaire is 3 hours, and the tool can be used regardless of the company's size.

Before the Polytechnic University of Milan developed the questionnaire, experts from Germany tried to describe as flexibly as possible the dependencies between various participants, processes and infrastructure elements in a factory operating within Industry 4.0

2.1 Architecture for digitally integrated businesses – RAMI 4.0

The proposed architecture model for companies that want to take advantage of the upcoming changes and digitization of the economy was published in Germany in April 2016. The study is called Reference Architectural Model Industrie 4.0 (RAMI 4.0). The primary pre-requirements are the need to define communication structures and the need to develop a common language with its own characters, alphabet, vocabulary, syntax, grammar, semantics and culture. If this is to be treated as the foundation of the solutions created later within Industry 4.0, one should assume that the paradigm of this phenomenon is the need for clear and unambiguous communication. The authors propose to see Industry 4.0 as a three-dimensional model. The layers of this model include such issues as physically existing assets and the way of transition to the digital world, access to information, necessary data, possible functions of assets and, as the top layer, the organization and business processes. Each of these layers can be examined and defined by two coordinates. One of them applies to the time in the product life cycle and the other one to the place of the product's creation in the organization with the accuracy from the product to manufacturing, control devices and service centers, to the enterprise and its location in the digital connected economy. The graphic image of the model is presented in the figure below.

Figure 4 - Industry 4.0 Architecture Reference Model1



Source - Industrie 4.0 platform and ZVEI

The benefits of such multi-dimensional look at Industry 4.0 is e.g. a good graphic perspective on the interdependencies of the various elements in business functioning over time. The requirement to create a new language facilitating communication between the value-forming layers and links seems deeply justified. The RAMI 4.0 model literally ensures that all the participants involved in discussions about Industry 4.0 understand each other.

Understanding the need for free and effective machine-to-machine and human-to-machine communication, an attempt was made to describe and parameterize the general ability of the business to transform in order to meet the requirements of Industry 4.0. A description of the target state of the organization is also necessary. Below presented are several digital maturity

models (hereinafter referred to as DMM - Digital Maturity Model) with a description of the special application conditions. At present, changes are taking place more dynamically, and the perspective on the digital maturity model varies depending on the industry and the culture of the country the model comes from. The majority of the models have common characteristics and also common are the business objectives consisting in generating profit and satisfying buyers' demands. The models described in the subsequent subchapters have been included in order to review different approaches to the subject.

Analyzing the subject literature, three approaches to digital maturity assessment can be observed. The first of them focuses on the technologies and solutions used in manufacturing. The second one focuses on determining maturity related to the organizational tissue and business changes. The third one is a mixed approach that can picture the whole image of digital maturity. A great number of the models created by consulting companies as tools for further assessment of companies within their analytical and advisory services.

Right now, RAMI 4.0 is the most dynamically developing standard for a complex architecture in Industry 4.0.

2.2 Optimal state of industry digitization – Singapore index

One of the first models, later becoming an inspiration for the followers, is Singapore "Smart Industry Readiness Index" (SIRI). This tool has been jointly developed by the Singapore Economic Development Board, German certification company TUV SUD and approved by a panel of industrial consultants and experts supported by Singapore government agencies. The purpose of preparing this index is to assign a uniform measure, a uniform framework for companies that want to modernize and want to derive benefits from the transformation. The authors of the index expressed hope that the index would allow for better communication between companies, employees, sectors and government organizations, as this would make it possible to prepare better for the transition to a new era of advanced production.

The SIRI tool is particularly recommended for manufacturing enterprises. It must be remembered that Singapore is the fourth exporter of technology products worldwide, right behind the USA, China and Germany. Manufacturing accounts for at least 20% of the domestic

GDP. Singapore has achieved its position thanks to a pro-business policy, competitive taxes, a solid intellectual property regime as well as educated, reliable and flexible workforce. Singapore has become the preferred place for innovation as well as development and testing of new ideas and solutions. Since November 2017 the Singapore index concerned has been regarded as the first world-class tool assisting industrial enterprises in making use of the potential of Industry 4.0 in a complex and systematic manner. The index authors expect 30% productivity growth until 2024.

Mr. Lim Kok Kiang from the Singapore Economic Development Board explains: " Many companies often put technology first. With this index, we put people and processes next to technology, so that companies could maximize the potential of Industry 4.0. "Therefore the index represents the mixed approach indicating that digital maturity is not only advancement in extracting and processing data but also the human and organizational aspect of the revolutionized industry.

The index has been designed as a comprehensive tool for all companies regardless of their size or the industry where they operate. The index incorporates all three basic elements of Industry 4.0 (technology, process and organization) and aims to find a balance between technological discipline and usefulness. The index is intended to equip companies with practical knowledge about the following matters:

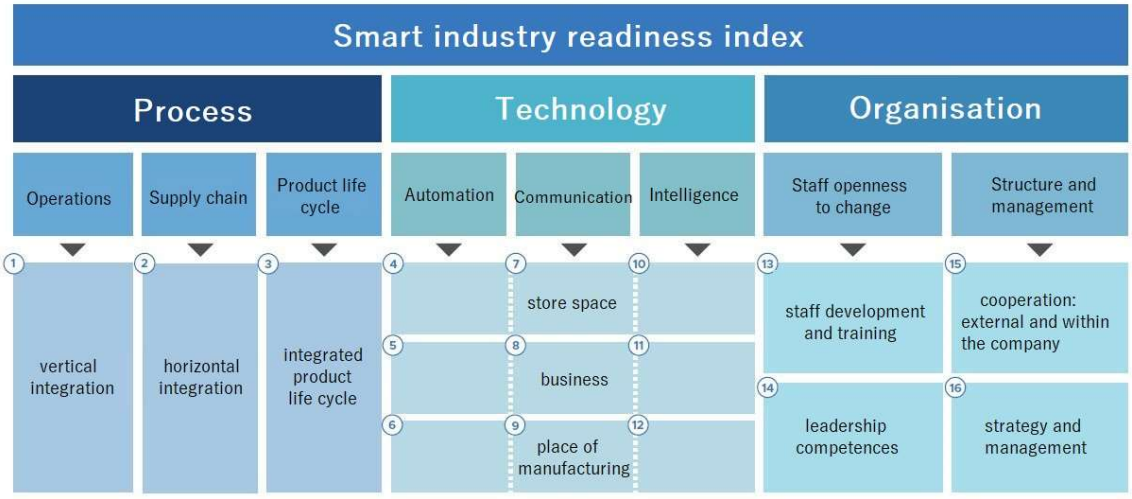
- What Industry 4.0 is and what measurable benefits it may bring,
- Maturity levels of the organization and its parts,
- How they can develop in a continuous and focused manner.

The structure of the index is divided into 3 main blocks based on 8 pillars. These blocks are: processes, technologies, organization. The eight block-supporting pillars are: operations, supply chains, product life cycle, automation, communication, business intelligence (understood as know-how), staff's potential to adapt to the new requirements as well as structure and management.

To describe the optimal state of a mature business in the conditions of Industry 4.0, the index has been equipped with sixteen dimensions, describing, on a six-degree scale (from 0 to 5) the level of fulfillment of the maturity criteria.

The diagram below shows in a short way the structure of the index.

Figure 5 - Structure of the Singapore Smart Industry Readiness Index2



Source: The Singapore Smart Industry Readiness Index,

https://www.edb.gov.sg/en/newsand-events/news/advanced-manufacturing-release.html

Terms of using the index clearly specify that:

1. The index provides a snapshot of the current state of the business, and not its potential in the future.
2. The index utilizes the concepts of Industry 4.0 as the point of reference. Where applicable, future concepts as well as manufacturing and industrial technologies should also be taken into consideration.
3. All dimensions should be formally taken into account. Depending on the current and future needs of the business and the nature of the sector, the importance of each pillar and dimension will be different.
4. The focus should not be put on achieving band 5 in all dimensions. Instead, businesses should aim at increasing the band, based on their specific business needs and aspirations.
5. The index should be used on the current basis, and not for a single assessment.

The index authors point out that businesses planning to become part of Industry 4.0 often have very different starting points, with varying potentials and different levels of ambition. Some of them will require a complex transformation of their operations, processes and business models.

Other ones may need a greater focus and exploration of the neighboring areas. One thing is certain - that regardless of the starting point or nature of the sector, businesses of any size will take advantage of Industry 4.0.

The Singapore index offers businesses the possibility to adopt a systematic approach to starting, scaling and sustaining transition initiatives. Although the relative importance of 3 components, 8 pillars and 16 dimensions will be different in various industries, the index tries to provide a common language for businesses in order to increase mutual adjustment, more effective collaboration and common innovations with external partners.

It is important to remember that a genuine test for the value of any index or model is its ability to reflect the reality and translate a concept into a real business value. The SIRI authors have made efforts to ensure that the index they have prepared passes this test and have developed four pragmatic steps that businesses can take for effective transformation. These four steps are included in the LEAD acronym. The acronym explains the proposed actions:

- L - learn key notions and build a common communication language,
- E - assess the state of the existing production assets and the company's readiness to act under Industry 4.0.
- A - architect a complex transformation strategy and its implementation plan,
- D - deliver value and sustain transforming initiatives.

The advantage of this index is its broad popularization and knowledge among production companies and companies that want to actively transform in order to take advantage of the opportunities involved in the changes related to Industry 4.0. For the purposes of reminding, the index was created on the basis of combining observations of very effective industrial companies in Singapore with a professional description, verification and parameterization made by professionals from international certification organization TUV SUD. The whole was later validated by experts from government agencies in Singapore. Such a method of creating the tool ensures its high quality and that it reflects the optimal state of operations of enterprises.

2.3 Impuls – i4.0 readiness – German VDMA engineers federation tool

Another tool worth attention is German model "Industry 4.0 Readiness". The development was commissioned by the IMPULS foundation, being part of the German Engineers Federation (VDMA) and conducted by IW Consult (a subsidiary of the Koln Economic Research Institute) and the Industrial Management Institute (FIR) at the RWTH Aachen University. The advisory role in preparing the study was delegated to VDMA experts and selected industry representatives. This model assesses maturity in 6 dimensions:

- strategy and organization,
- smart factory (allowing for scattered and automated manufacturing),
- smart operations (well-considered actions that affect the production process),
- smart products (products equipped with ICT components),
- data-based services (data-based services, embedded in business processes) and
- qualified personnel.

In each of the six areas, the respondents evaluate themselves using six maturity levels. The questionnaire can be filled in at https://www.industrie40-readiness.de

2.4 Polish approach to digital maturity assessment

~~The transfer of the Singapore model's functionality to the Polish reality is currently in the executive phase.~~ Under the project "Support for Industry 4.0 in Poland" commissioned by the Ministry of Enterprise and Technology, the first ~~prototype of a~~ tool for digital maturity assessment of enterprises has already been created. The index drawn up in Singapore was an inspiration for the authors of the Polish model. It has been elaborated by DELab UW, namely a research center established by scientists from the University of Warsaw. The experts represent different domains (sociology, law, economy) delivering studies and expert's reports supporting innovation processes, increasing effectiveness, and optimizing organizational processes.

According to the authors, the tool has ~~already~~ been consulted among experts specializing in manufacturing technologies, process automation, production management and the functioning

of IT solutions in business. The consultations have also been conducted among the practitioners of strategic change implementation in business and human resource management practitioners.

The digital maturity assessment tool defined by DELab has been built with regard to the key development aspects of an enterprise in the context of Industry 4.0. The respondent has the possibility of identifying the stage of development of the enterprise in several dimensions based on three main pillars regarding: organization, technology and processes. After answering 12 substantive questions and providing 8 short pieces of statistical information about the company, a survey participant receives assessments of the development level of key aspects in the company being examined.

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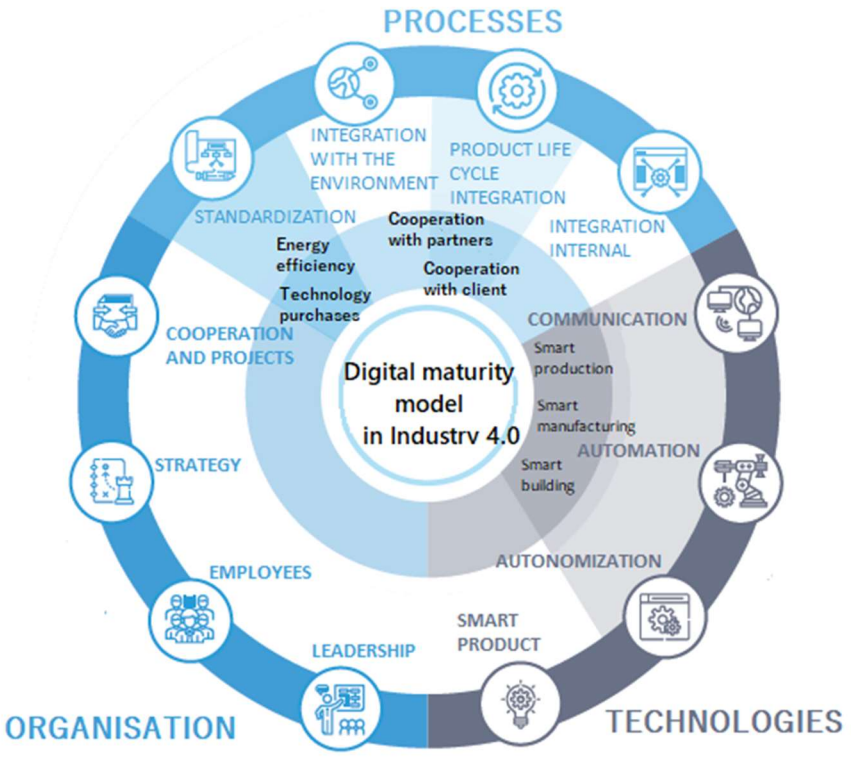
Figure 6 - Graphic presentation of the digital maturity model authored by DELab UW3



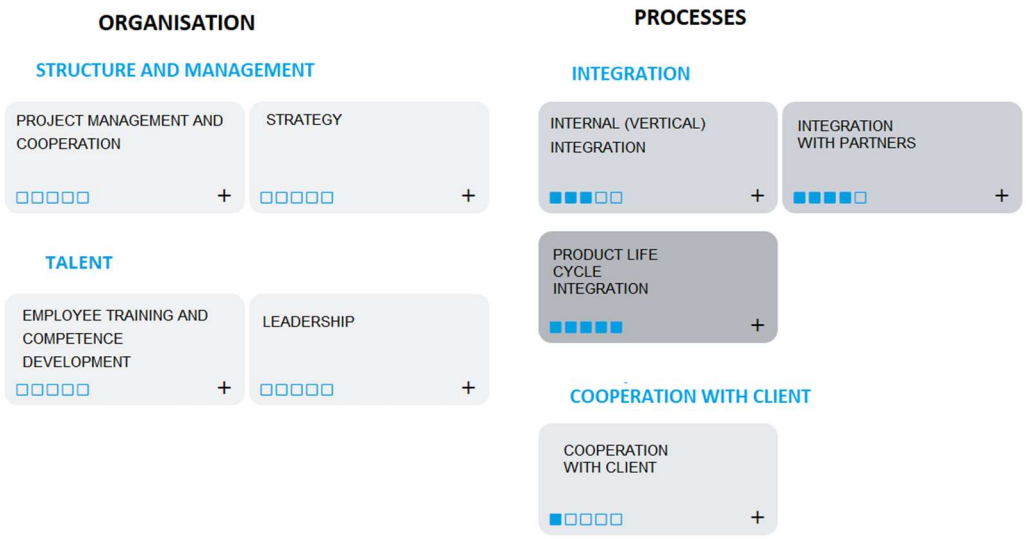
Source: DELab research center, Warsaw University, https://delab.uw.edu.pl

The purpose of the adopted methodology is functionality of the tool allowing for an initial assessment of the development stage of the enterprise towards Industry 4.0, indicated by the organization's maturity level. The tool's usability also assumes presentation of the recommendations from the obtained assessment.

The authors clearly indicate that the tool is supposed to indicate only the development direction. Optimal maturity levels will vary between sectors and can change depending on the business strategy. Therefore, it is important to interpret the index well.

~~The tool's prototype~~ The tool can be used for free by replying to the questions posted at https://dojrzalosc40.delabapps.eu. It takes about 15 minutes to complete the survey and, as feedback, the respondent receives quite a legible graphic presentation, regarding the level of digital advancement in various areas related to the earlier mentioned three pillars.

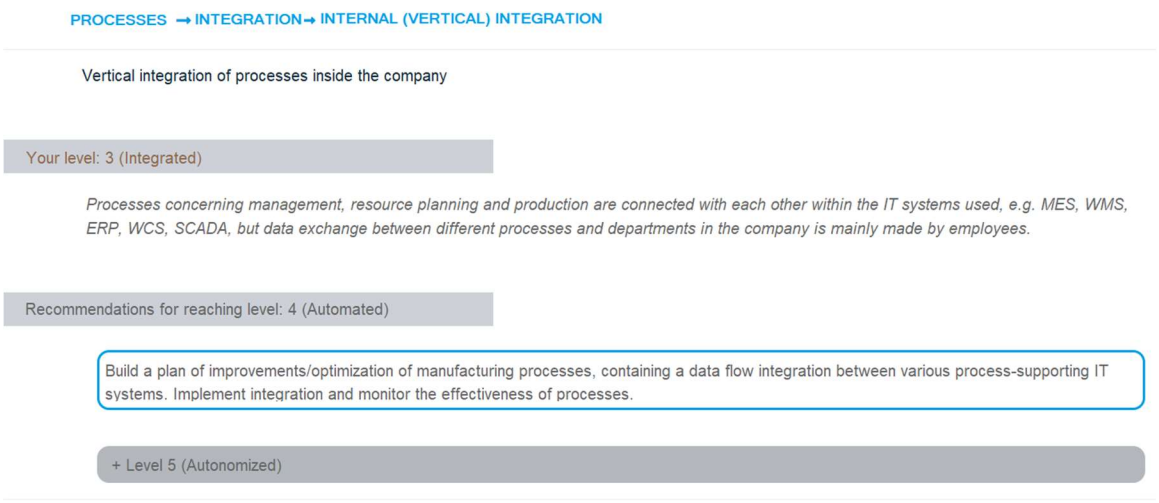
Figure 7 - A fragment of the graphic presentation of a sample analysis result with the use of DELab UW model4



Source: prepared by the authors

Each of the areas incorporates recommendations available after clicking the "+" sign. Below we include an example of such a recommendation.

Figure 8 - A sample description of the Industry 4.0 maturity diagnosis using the DELab model and recommendations for the area development5



Source: prepared by the authors

Assistance in the diagnosis of the preparation for the digital transformation can also be obtained at Przemyslprzyszlosci.pl managed by the mentioned Platforma Przemysłu Przyszłości (Future Industry Platform) Foundation. The platform supports:

- digital transformation processes
- implementation of digital products and services
- introduction of business models based on the newest solutions in the field of e.g. smart data analysis, automation and machine-to-machine and human-to-machine communication, process virtualization as well as cyber security.

One of the main goals of the initiative is also to strengthen staff competences for the industry of the future. The website also includes a tool for the initial assessment of the company's preparation to function within Industry 4.0, it is the same questionnaire prepared by DELab UW, described above and available in this case at https://przemyslprzyszlosci.gov.pl/kierunekprzemysl40/.

After a few years of developing the i4.0, concept, the proposed tools for modeling and assessing the organization's maturity started to evolve towards applications focused on a specific industry. For example, in April 2019 a group of scientists from Poznań published the study "Building a model for assessing the maturity of Polish enterprises in terms of Logistics 4.0 assumptions", which may constitute the basis for the development of an independent diagnosis and evaluation tool for logistic companies.[21]

The advancement-determining levels in the transformation towards Industry 4.0, most commonly used by the models are:

- 0 – outsider,
- 1 – beginner,
- 2 - intermediate,
- 3 – experienced,
- 4 – expert,
- 5 – best contractor.

The first two levels characterize enterprises beginning their way to the transformation and the three top ones describe organizations effectively implementing the changes on schedule.

In the study "On the Pulse of Digitalization, Deloitte Digital Maturity Index", Deloitte Digital not only evaluates the level of advancement on a similar scale, naming them digital maturity archetypes, but also specifies the estimated size of the group. In the table below, these archetypes are named and the estimated percentage of their occurrence is determined.[22]

21 P. Cyplik, J. Oleskow-Szłapka, A. Tobola, M. Adamczyk, Building a model for assessing the maturity of Polish enterprises in terms of logistics 4.0 assumptions, Business Logistics in Modern Management, 2019, vol. 19, 105-120

22 On the Pulse of Digitalization Deloitte Digital Maturity Index, Deloitte Digital, https://www2.deloitte.com/content/dam/Deloitte/de/Documents/operations/Deloitte_Digital_Maturity_Index.pdf

Table 4 – Archetypes of a digitally mature business

Archetypes of a digitally mature business	*percentage*
Latecomers (minimum actions on the strategy and operations level; no digital abilities in the strategy and operations dimensions,	7%
Observers (minimum actions on the strategy and operations level. Observers are trying to consistently develop digital abilities in both dimensions. They are actively working on the transition to the next archetype "Activists")	33%
Activists (implementing operating actions and avoiding strategic activities; focus on digitization of the main value chain, in their success relying on flexibility by implementing innovative solutions)	8%
Innovators (act strategically avoiding activities in the area of operations; innovators demonstrate a significant progress in the digital business (by an innovative portfolio), however with an average operating success))	8%
Potentials (operating and strategic actions with considerable success; concentrate on digital strategy development along with operating excellence in order to achieve cost benefits.)	40%
Masters (operating and strategic actions with considerable success, Masters combine a coherent digital strategy with operating excellence to achieve full flexibility)	5%

Source: Deloitte Digital

Experts the authors of this study emphasize that the basis for success is simultaneous and harmonious development at the strategy (e.g. new digital business models, digitization of products and services) and operations level (digitization of business functions).

3. Digital maturity models in INNO PROVEMENT project partners' countries

After analysis of the materials from the partners in the INNO PROVEMENT project and after verification of the available sources, it can certainly be determined that there is no one, universal model or tool for digital maturity assessment. The solutions taken into account differ in the structure complexity, the spectrum of information collected and the scope of information returned. These models also present various points of view, mainly because of the uneven development of the national economies the project partners come from. The cooperation within INNO PROVEMENT connects, among others, partners from Greece and Finland. Both these countries are on the opposite ends in the reports on digital maturity levels in Europe. While in Finland the developed digital transformation support model has already been tested and brings measurable benefits in use, the partners from Greece have completed an analysis of the state of digital maturity. The details on the results of the analyses discussed are presented further in the document.

The following review is to deliver information about the possible approaches to effective support for SMEs in digital transformation, which is related to the stage of assessing business maturity.

3.1 ADMA – European Commission's initiative

In connection with the requirements of the environment resulting from Industry 4.0 (i4.0), in June 2018 the European Commission initiated the development of the new European Advanced Manufacturing Support Center (ADMA Support Center ADMA Support Centre). The Consortium

that became involved in the implementation of this project consists of technological firms and non-technological companies, including experts in communication and training partners. From Poland the partner in the initiative is e.g. the Industrial Institute of Automation and Measurements based in Warsaw. The first part of the project is a study of the current situation that is to take 36 months namely until May/June 2021. The initiative was created after an analysis of the technological and social expertise among SMEs, which turned out to be limited in a high number of cases. Such companies often fail to thoroughly realize, what knowledge, what equipment and what actions are necessary to satisfy the changing demand. The task of the ADMA support center is to identify and respond to the needs of SMEs regarding technologically advanced manufacturing methods and share personal contacts with representatives of factories and consultants. The Center will pursue its tasks by:

- development of a unified methodology for the transformation of SMEs,
- certification of consultants during train-the-trainer sessions,
- testing the methodology in the EU member states,
- establishment of a network for exchange of common experience to pursue mastery,
- organization of showcase events under the slogan "Factory of the Future".

The ADMA support center has created and makes available free of charge online the possibility of unassisted check (the so-called scan) of the business's digital maturity, the enterprise's readiness for actions to transform the organization to the requirements of i4.0. This tool includes 17 questions, on the basis of which the user will get a diagnosis and recommendations for further decisions related to the development of the digitization strategy. The tool is addressed for businesses from various industries and of various sizes. The scan covers 7 transformation areas:

- advanced manufacturing technologies,
- digital factory,
- environmental focus in a factory
- customer-oriented engineering,
- organization putting the human at the core of attention,
- smart manufacturing namely smart production,
- open factory focused on the value chain.

The scan concerned is planned only for manufacturing companies. the report version in Polish includes more than 50 questions, on the other hand, the number of questions in the English version, available directly from https://adma.ec, is a little higher than 20. The results present only the percentage of the answers provided by other respondents. In addition, there is a very high probability that they are unreliable. Many answers were omitted and the number of the completed scans does not match the number of the answers provided.

A better solution is to conduct a scan using the tool in Polish that is available at https://www.surveymonkey.com/r/K77WSFQ. Each of the 51 questions includes 5 answers scored from 1 to 5. Checking only the first answers already gives 51 points out of 255 possible ones, representing the result 20%. This initial analysis does not present any suggestions of actions for an entrepreneur. By completing the questionnaire, one can only gain the knowledge what questions should be asked in the context of the transformation to i4.0 and see from the structure of the answers what is the suggested target state. The surveys (in Polish and English version) are made available on a free server used to create surveys and are mainly used to collect contacts for advisory companies. A rich set of questions may certainly be an inspiration when creating one's own tool for assessing the maturity level.

3.2 Other tools from other European countries

Some of the models discussed below serve an initial self-assessment of maturity and utilize a simple-to-complete questionnaire made of a dozen or so or a few dozen questions. Other ones are characterized by greater inclusion of the examined company's personnel and are a rich source of thoughts for the implementation of specific actions. Below we present several models used in INNO PROVEMENT program partners' countries.

The presentation of information has been arranged according to the DESI index value for particular economies, from the lowest to the highest results. The place in the DESI ranking for 2020 and the point value of the index are specified in brackets at each of the countries.

3.2.1 Greece

Greece is a state which, as it results from the assessments, is at the beginning of the digital transformation path. Such an opinion may be drawn e.g. based on the analysis of the DESI integrated index levels, which ranks Greece 27th among 28 member states in 2019 and 2020. The index was established for the purpose of measuring EU countries' progress on the way to an efficiently working digital economy and digital society. [23]

A similar level is indicated by the digital maturity index drawn up in Greece.

The Greek federation of entrepreneurs, with support from the consultancy firm Deloitte, has created the Digital Transformation Observatory (DTO), whose goal is to monitor and promote the digital transformation of Greece. For the needs of the Observatory, the digital maturity index has been created, consisting of approximately 100 published key indicators. They monitor the state of the national economy in 7 different dimensions. Four of them have been considered the digital transformation enablers, and these are: ICT/high tech sector, communication infrastructure, politics and legal framework, digital abilities. A result of the correct operation of the enabling dimensions are the resulting dimensions defined as: digital maturity of business, digital maturity of the society, digital maturity of the public sector. The index for Greece calculated on this basis reached 3.7 giving this country the last, 28th place among the examined European countries. For comparison, the index calculated for Poland is 4.3 with the average from the examined countries amounting to 5.2. Sweden with the index level of 6.4 occupied the first place in 2017, on the other hand, in the subsequent year the winner was Denmark with the result 6.5. In 2018 the first five of the most mature states also included the Netherlands, Finland and the UK.

The index examines digital maturity on the global level comparing national economies, and consequently, it is not useful for evaluating the business's readiness. For the needs of any possible future studies of the environment and determination of the measure of reference, weights of particular subdimensions have been included in the analysis report below, as used to create the SEV DM Index:

23 DESI – Digital Economy and Society Index developed by the European Commission.

- Technology sector: ICT contribution – 40%, and the following 15% each: ICT business activity, ICT research activity, contribution of the high tech production sector, contribution of the knowledge-based services sector
- communication infrastructure: broadband Internet access coverage 50%, broadband communication of households and businesses – 25% each for each of the subdimensions,
- Politics and legal framework: support for the digital transformation environment – 20%, and 40% weight each: prioritization of the digital transformation and digital transformation-related legislation,
- Digital abilities - digital abilities of the population and digital abilities of businesses affect this dimension half by half,
- Digital maturity of businesses - 45% - degree of integration of digital technology solutions, 40% - degree of adaptation of digital solutions, 15% - digital security,
- Digital maturity of the society - 25% each of the following: access to the Internet, using online services, dissemination of online shopping, 15% - access to the Internet from mobile devices, 10% - degree of information about digitization matters,
- Digital maturity of the "public" sector – 30% is the degree of digitization of the public sector, 25% level of using electronic services, 15% open data sources, 10% each: usability of services, basic conditions for services provided digitally and friendliness of the services offered for use on mobile devices.

Many of these parameters are the subject matter of research by Statistics Poland (National Statistical Office, GUS). This gives the possibility to simulate a twin index for the needs of comparison of the digital maturity level across voivodeships. Information on this subject is included further in the document in the Recommendations section.

Preparing the information on Greece's approach to measuring digital maturity, it was observed that the actions taken apply to the macro-scale and are analytical in nature.

At the same time, with the analysis of the Greek index results, we are presenting the index's point levels for countries of origin of INNO PROVEMENT program partners: Finland 4 place/index value 6.4 pts., European average 5.2 pts.; Portugal 16/5.1 pts.; Czech Republic 18/4.9 pts.; Hungary 22/4.4 pts.; Poland 23/4.3 pts.; Italy 24/4.3 pts.; Greece 23/3.7 pts.;

3.2.2 Italy

Similar studies were also conducted in Italy in the Marche region. Based on their results, a SWOT analysis of the digital transformation of the industry was developed. The identified strengths of the Marche region are the wide presence of solutions for data analysis, information transmission and production automation. Weaknesses are: lack of big data solutions, sensor-based systems (IoT). The biggest opportunity of the region in terms of implementation of Industry 4.0 solutions is the growing knowledge and awareness of companies in relation to the benefits of digital technologies. The main threat is the lack of knowledge about which technologies will be useful in the future, in which direction the digital transformation will develop globally. This can lead to wrong business decisions, misguided investments, etc.

3.2.3 Poland

The most common tool for digital maturity assessment in Poland is the model made available by the Platforma Przemysłu Przyszłości (Future Industry Platform) foundation. As demonstrated earlier, it is the same tool as the model developed by DELab at the University of Warsaw, based, among others, on the Singapore Smart Industry Readiness Index. The usability of the model available on the platform consists in completion simplicity (3 areas, 4 questions each) and useful feedback information. They contain not only maturity assessment but also basic action recommendations. This model is the obligatory assessment tool for created DIHs (Digital Innovation Hubs). More information on the model is included in the previous chapter of this study.

3.2.4 Hungary

Hungarian Ministry of Finance have presented a platform for the exchange of knowledge and connecting together Industry 4.0 stakeholders. The National Technology Platform (NTP) of Industry 4.0 was established in May 2016. It was formed under the leadership of the Institute of Computer Sciences and Control of the Hungarian Academy of Sciences, presently operates under the patronage of the Ministry of Innovation and Technology. Its establishment was broadly supported by universities, research institutes as well as companies and corporations operating in Hungary. The platform is available at https://www.i40platform.hu.

To determine the level of preparation of Hungarian enterprises for the transition to Industry 4.0, in 2017 NTP conducted a single survey online which entrepreneurs filled on their own. It consisted of 98 questions, 46 of which directly studied maturity in the context of i4.0. These questions were prepared on the basis of a questionnaire earlier prepared by German association VDMA. Other areas gathered business and statistical information and opinions about the present and the future situation of Hungary in the context of the transition to i4.0. The application of this model was to analyze the state of the Hungarian economy in terms of readiness for the transition and digitization. Simultaneously, as part of the "Economic Development and Innovation" Operating Programme, more than thirty focused interviews were conducted. Results of the interviews were combined with the results of the previously mentioned surveys and, on their basis, the basics for further activities were determined, in order to prepare SMEs in Hungary for the digital transformation.

3.2.5 Portugal

In Portugal the partner in the INNO PROVEMENT project is COMPETE 2020, namely the Managing Institution of the Competitiveness and Internationalization Operating Programme, established in December 2014. Compete2020 is a structure within the Central State Administration responsible for the "Shift to 4.0" tool . This is a diagnostic tool allowing for self-assessment of the preparation for transformation towards Industry 4.0. The tool allows for an easy assessment of the state of digital maturity, regardless of the sector, size or location of the enterprise.

The tool was developed by ISQ group and is promoted by IAPMEI. ISQ is an international private business organization from the technical industry, with more than 50 years of experience and 16 laboratories. ISQ employs more than 1500 employees worldwide, conducts more than 500 different research projects, engaging more than 1200 domestic and international partners. A public institution is responsible for promoting the tool among entrepreneurs, namely the Institute of Support for Small and Medium Enterprises and Innovation (IAPMEI - Instituto de Apoio às Pequenas e Médias Empresas e à Inovação). "Shift to 4.0" is a self-diagnosis tool supporting

decisions in order to take action and make investment in i4.0. A self-assessment report is generated automatically after the survey has been completed. [24]

The applied survey methodology was based on a questionnaire developed by IW Consult from the Cologne Institute of Economic Research and FIR RWTH at the University of Aachen, and then adjusted to the Portugese reality with support from ISQ. The Portuguese model, just like the model specified by VDMA, consists of 18 dimensions arranged in 6 areas. Describing its methodology, the authors of the tool state that the maturity assessment is obtained using weighted average and provide weights of particular areas: [25]

- 25% - strategy and organization,
- 14% - smart factory,
- 10% - smart operations,
- 19% - smart products,
- 14% - data-based services,
- 18% - human resources.

Under the obtained assessment result, the examined company receives a spacious report with the guidelines how to improve its path of transformation. The report is sent in a PDF file to the e-mail address provided when starting the survey. The report, apart from the graphic presentation of the result, includes recommendations for each of the dimensions studied. It includes all the answers provided along with the questions they were concerned with. Such a summary is very beneficial for several reasons. From the point of view of evaluation of the digital transformation, it gives a possibility to compare two maturity states at various points in time. Furthermore, in the case of differences in the answers provided by employees of the same enterprise at the same time, it gives an opportunity to compare the answers, find the differences and discuss the basis for them.

It is worth emphasizing that the self-assessment form is interactive and allows some questions to be ignored by companies which have no production hall. It makes it easier for smaller

24 https://www.isq.pt/, [access: 22.07.2020]
25 Modelo base de ferramenta SHIFTto4.0, https://shift4.isq.pt/doc/metodologia.pdf

companies and for non-production businesses to conduct the self-assessment. It takes approx. 15-20 minutes to complete the survey and it is completed by an automatic graphic and tabular presentation of the result.

Figure 11 - sample result received using the SHIFTto4.0 tool6

Wymiar	Motyw	Klasyfikacja
Strategia i organizacja	Strategia	1
	Inwestycje	3
	Zarządzanie innowacjami	4
Smart Factory	Infrastruktura sprzętowa	0
	Modele cyfrowe	0
	Kostka do gry	0
	Systemy informatyczne	0
Inteligentne operacje	Udostępnianie informacji	3
	Autonomiczne procesy	3
	Bezpieczeństwo IT	4
	Chmura	5
Inteligentne produkty	Funkcje ICT	0
	Analiza danych	0
Usługi oparte na danych	Usługi oparte na danych	3
	Źródło przychodu	1
	Poziom użytkowania	2
Zasoby ludzkie	Istniejące kompetencje	2
	Nabycie umiejętności	3

Source: prepared by the authors

The interactivity of the tool makes it also possible, after receiving the result, to check the area development level in a 5-year time perspective. Below presented is a summary of the strategy dimension from the test survey.

"Strategy. Current state: i4.0 is already being implemented at the level of departments in pilot initiatives, but misses integration with the company's strategic process.

Recommendations: Develop a feasible i4.0 strategy and integrate it with the company's strategic process. Then, define a particular i4.0 strategy, initial implementation measures and apply the i4.0 strategy in practice. The implementation measures and steps help to integrate the strategy in the company".[26] As one can see, the recommendations are very general in nature. When finishing the

26 Ibid.

process of completing the questionnaire, one can check the request for contact from the survey organizer in order to discuss the result and plan further detailed transition actions.

It should be noticed that the study is prepared in a very professional way and may serve as an example to follow. The Portuguese partners approach very openly the communication with potentially interested enterprises. Apart from SHIFTto4.0 assessment model, additional materials for the interested parties have been posted on the website the model is available at. These are, among others:

- A list of all the survey questions, to be downloaded as a PDF file,
- Description of the survey methodology,
- A webinar on the SHIFTto4.0 model "Zero transformation moment". The webinar duration is 1 h 36 minutes,
- Pilot study report.

Although the materials are in the Portuguese version, it is worth taking a closer look at how the authors of the tool approach the communication with the survey participants.

3.2.6 Czechia

For the partners from Czechia, the digital maturity assessment model made available by the Ministry of Industry and Commerce of the Czech Republic was subject to the analysis. Enterprise's self-assessment consists in completing and sending the survey available at firma4.cz. The survey form consists of 32 questions with five answers, the majority of which offers possible single choice. Three questions offer multiple choice options. The answers contain a definition of the state of the problem examined, which have been collected within 5 below presented thematic areas.

1. Leadership, human potential, openness of corporate culture to digitization,
2. Business model, customer focus and digital product,
3. Operative model, digital value creation environment and digital control,
4. Technology,
5. Work with data and data culture.

The answers sent are then analyzed by a team under the supervision of an external expert. The tool is intended for all enterprises regardless of size and industry.

3.2.7 Finland – European leader

Referring to the digital maturity index prepared in Greece, indicating Finland as the leader in digitization, in this part the analysis will focus on a description of the Finnish approach to maturity assessment. Assessment model named ApuaDigiin (from Finnish – assistance in digitization) has been prepared with support from the Oulu regional council together with the VTT Technical Research Center. The model along with a tool for digital maturity assessment is available at https://www.apuadigiin.fi. After entering the site the guest is welcomed by a simple message saying that Finnish entrepreneurs will find on the website information about a "systematic and controlled process of switching to digital solutions, which take account of the risk, possibilities and the present state of the company so as to ensure that digitization becomes a natural part of its operations". The site combines the educational function with the analytical function. Apart from a graphic presentation of the model, tools have been made available, helping to reflect the company's digital maturity. Digital maturity assessment is just one of elements of this systematic and controlled transformation. The tools discussed are DigiMature, DigiSWOT and DigiKolmio. [27]
The presented transformation model assumes 4 main action stages:

1. Maturity assessment – mapping of the target state of digitization in the organization's various operations and enterprises,
2. Positioning - describing the company's digitization level; an analysis of development progress is prepared for selected digitization priorities and a solution with a clear target level is proposed,
3. Transformation map – formulation and development of the implementation map containing tracing indicators, whose task is to allow for later evaluation of the transformation,
4. Implementation – implementation of the developed digital transformation solution and assessment of the obtained functionality.

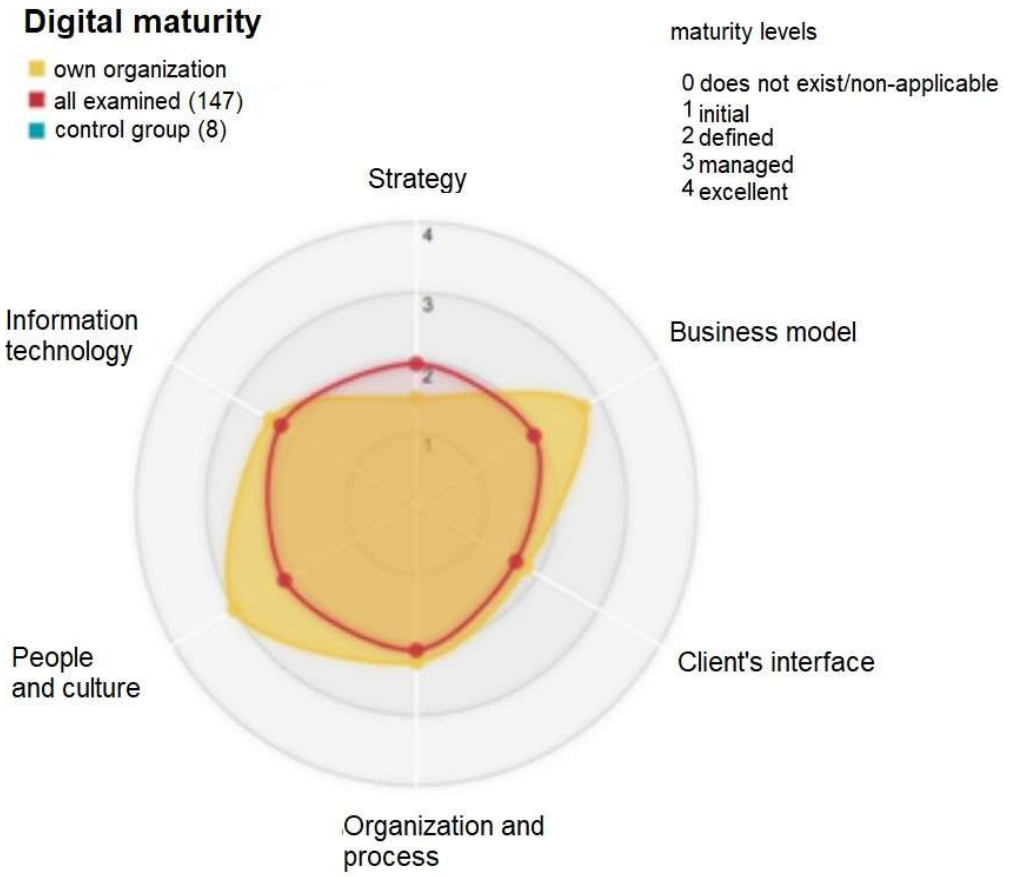
27 apuadigiin.fi, [access: 23.07.2020]

The DigiMature tool can be used for the enterprise's digital maturity assessment, being also available directly at https://digimaturity.vtt.fi. The dimensions describing digital maturity according to the tool are::

1. strategy,
2. business model,
3. contact with the client,
4. organization and processes,
5. human resources and organizational culture as well as
6. IT technologies.

It takes about 15 minutes to give answers to the questions, and then the tool presents the result graphically, as in the following example. The questionnaire is very intuitive and legible to complete. All questions are placed on one page with possible scrolling, thus, it is easy to move across the areas and change the answers pursuant to the changing understanding of the subject area while completing the questionnaire. By completing statistical information 'about the company', the participant can choose among more than 60 sectors, with the benefit being that the information collected by the tool owner makes it possible to e.g. better monitor entrepreneurs' activity and make a point of reference to the industry competitors available to them. The tool is free to use, it only requires an account to be set up, for which the only data required are an e-mail address and last name.

Figure 9 - Graphic presentation of results of a sample company examined with the use of the Finnish digital maturity model7

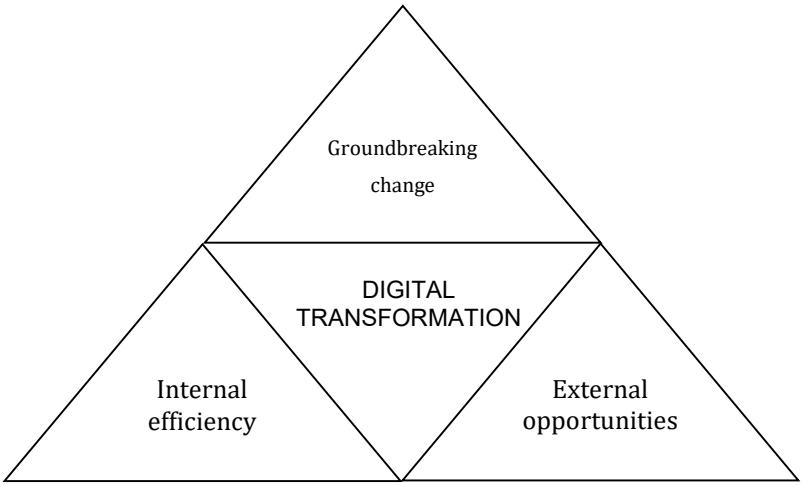


Source: prepared by the authors with the use of ApuaDigiin.

The second tool is DigiSWOT. It is a well-known strategic business analysis tool, in this case focused on the digital action perspective, available as a PDF file from the website. Another tool is also available in the form of a file for individual printout - DigiKolmio (from Finnish *kolmio* is a triangle). According to the authors "the digital triangle allows arrangement and presentation of the development needs and ideas related to digitization". According to the Finnish concept, the digital triangle consists of three areas: internal effectiveness, external opportunities and groundbreaking change. In the "internal effectiveness" area, any ideas related to digitization that offer an improvement in the effectiveness of processes in the company should be described.

These can be e.g. new IT solutions, new production methods or integration of the existing solutions. The "external opportunities" area is the place for collecting the so-called digital ideas for contributing higher value for the organization's clients and partners, including e.g. new services, e-marketing or improvements in communication with the stakeholders. The third among the digital triangle areas is "groundbreaking change". Its task is to collect radical ideas for the digital change in the company's action. These are to be any ideas that may enable a completely new type of operations, new partnerships, or even the company's refocusing on a new role in delivering value to the market. [28]

Figure 10 - DigiKolmio – Digital Triangle - one of Finnish tools promoting digital transformation8



Source: on the basis of ApuaDigiin.fi

Entrepreneurs from SMEs are also offered other support tools, apart from the aforementioned main three ones. The following are available:

- Business Resilience Tool – illustrates graphically the ability to introduce changes in four various phases of business change (defined stages: analysis phase, innovation phase, objective setting phase, implementation phase),
- list of questions – over 40 questions assisting in the course of creating the Digital Triangle,

28 Ibid.

- Road Map – a simplified and initially prepared schedule of activities for subsequent 18 months, available in an Excel sheet, with a short information how to adapt it to the company's requirements,
- Clock of the Year – an editable graphic available in a PowerPoint and OpenOffice format file, with a circle divided into 12 fields, for checking the digital transformation milestones,

Together with the digital maturity self-assessment models there are many other hints and suggestions presented, allowing an SME entrepreneur to enrich their knowledge about the digital transformation and the process of its implementation. ApuaDigiin is a set of tools intended to raise interest in the digital transformation and help to start the process. For businesses that are more advanced in the transformation, it delivers information making it possible to find references relative to competitive companies from the sector.

It is also important that the tools available as ApuaDigiin have been developed not only for SMEs but also for seniors, understood as employees with long seniority. The introduction of digital changes may be a challenge for those persons, while being something natural for the young.

3.3 European Digital Economy and Society Index – DESI

The order of presentation of the above tools has been arranged according to the increasing value of the DESI index (Digital Economy and Society Index), which the European Commission has been publishing since 2014. This index is an aggregated measure consisting of the indexes regarding the present European digital policies. Its task is to keep track of the evolution of the member states regarding digital competitive advantage.

The DESI index is calculated on the basis of 34 indexes grouped in five major areas that have been described in the table below. A full set of the indexes and the methodology of calculating the DESI index are described at https://ec.europa.eu/commission/presscorner/detail/en/MEMO_19_2933. As mentioned earlier in the report, in the context of assessing the digital advancement of the Łódzkie Voivodeship, information describing the structure of the index may be an inspiration when building a possible new proprietary measure or the need to calculate the index for the Łódzkie Voivodeship.

Table 5 – Five major component areas of the DESI index

1. Communication	Constant access to the Internet, mobile access to the Internet, quick and super-fast access to the Internet and prices
2. Human capital	Internet use abilities and advanced digital skills
3. Use of the Internet	Use of the Internet and use of online transactions by the inhabitants
4. Integration of digital technologies	Digitization of business and e-commerce
5. Digital public services	e-office and e-health

Source: European Commission's materials

The reason for presentation of the DESI index in this report is the willingness to show the level of digitization of the economy and the society according to a uniform measure, which refers to each of the partner countries in the INNO PROVEMENT project. DESI index values for the year 2020 for the countries - partners in the INNO PROVEMENT project are presented in the table below.

Table 6 – DESI index value for selected countries in 2020

Country	Place among EU countries	Index value in 2020
Finland	1	72,3
Czechia	17	50,8
Portugal	19	49,6
Hungary	21	47,5
Poland	23	45
Italy	25	43,6
Greece	27	37,3

Prepared by the author on the basis of the European Commission's data

4. Analysis of the opportunities to use the digital maturity models in digital and technological innovation support projects for SMEs

For the needs of this analysis, a description of innovation has been adopted, as "the first practical (commercial) introduction (application) of a new product, process, system or device" that becomes popular on a larger scale[29]. The same author distinguishes three fundamental types of innovation: product (new products), process (new manufacturing processes) and service (new services), among which the role of the latter is significantly growing. First, services play an increasing role in the changing market economy, secondly, they are often a result of the technological progress. The genesis of innovation is innovativeness defined as successful utilization of new ideas. It can be assumed that innovation relies on searching for solutions, opportunities to verify them and their effective implementation. The effectiveness of innovative operations will be assessed by each entrepreneur separately, in relation to their specific business situation and plans for the future, the development strategy. As we can see from the study conducted by Computerworld quoted above in Chapter One, the vast majority of the companies surveyed, as much as 75%, does not link operations with the strategic adjustment to the future, including to Industry 4.0. A question should be asked: what is the reason for such a state of affairs. The answer can be complex and depend on many variables, including the level of the enterprise's development, the industry it operates in, sale markets. Whatever the measure attached to the assessment, it is important to remember that the development of the action strategy and the enterprise's development is responsibility of the senior management. It is nothing else but this

29 H. Jasiński, *Innovativeness in the Polish economy. Models, barriers, support instruments,* Scientific Publishers of the Faculty of Management at the University of Warsaw, Warsaw, 2014

management level that determines the decisions regarding development, regarding the way of expanding knowledge and experience among lower level personnel and establishing partnerships with other market participants.

As demonstrated earlier on the basis of the analysis, Industry 4.0 assumes exchange of a huge amount of information within the enterprise itself but also among its stakeholders. This circle is continuously broadening and will include more and more organizations, including offices and scientific organizations. The adaptation to changes will not only require effective data processing and rapidly drawn conclusions, but also effective communication with the partners.

Partner cooperation is becoming a more and more important milestone on the way to create an innovative economy, on the way to adapt to Industry 4.0. Cooperation should include, among others, constant staff education, knowledge transfer from academic centers and common works with universities on exploring and development of new ideas that stand a chance of becoming innovations. Taking the above assumptions, it is very reasonable to check more accurately, using the digital maturity assessment model, the actions taken by entrepreneurs in the strategy and staff development areas. From this point of view, it is worth paying attention to the Portuguese model, which assigns a total of 43% in weight to the dimensions related to strategy and business organization as well as those related to staff competences in the final maturity assessment in the context of Industry 4.0. It must be indicated that the strategy and organization dimension is as much as 25% of the general weight of the assessment according to the model concerned. In each of the analyzed models, there is an analysis of the strategic and HR dimension, however, only the Portuguese model clearly shows such a high rank of both in the overall evaluation of the preparation for the transformation.

Analyzing the above-described digital maturity models, it should be noticed that their usability in support for digital and technology innovations will largely depend on the development level of the management staff in SMEs. The above mentioned ability to arrange the strategy and take strategic actions requires broad knowledge and experience of the management staff. When there are no such competences on a sufficient level in SMEs, it must be ensured that the maturity assessment model also fulfills the educational function and shows better the benefits from the transformation. An SME representative, approaching verification and examination of the Industry

4.0 concept and the grounds for the introduction of changes in their company, will be looking for information about the business benefits this transformation will bring. This was strongly emphasized by the participants of one of the conducted studies.

In this context attention should be paid to the Finnish model, which makes information on other companies' success cases easily available. Interestingly, the result of the study also shows a reference of the received assessment to the average results obtained by companies from the same industry. The studied entrepreneur immediately gains knowledge not only about their own maturity but also about their position as compared to the competitors. The results are presented on a very high level of generality, however, showing a reference to the average level in the environment, provide very important information to the entrepreneur. This information may encourage him or her to act and use support.

The more attractive and clear the way the results of the digital and technological transformation are described, the higher the chance that an SME will apply for support. In many cases, SME management staff may not have the necessary qualifications for substantive assessment of the grounds for the transition. The vocabulary described in the questionnaires or the literature concerning Industry 4.0 can deter particularly those managers who do not develop their competences on the permanent basis.

In this context, the Finnish approach is again worth consideration. When visiting the site https://www.apuadigiin.fi, an SME representative finds information on digitization described clearly and using a simple language. The tools posted on the site, including the digital maturity assessment model, allow the user to verify the justification for gaining any further knowledge about the transformation. The partners from Finland underline the fact that the tools were developed so as to ensure that they are friendly for seniors not having any current contact with technological novelties, trends and innovation. An SME representative does not need to have sufficient knowledge on Industry 4.0 and management principles. Using an intuitive questionnaire and tools such as the SWOT matrix and the "Digital Triangle", he or she can picture his or her company's state of readiness for, as Fins write, the "digital leap". After completing the digital maturity assessment and filling in DigiSWOT and DigiKolmio, the entrepreneur holds several basic information that may serve further decision making related to the transition. In the case of a

deeper interest in the subject matter, the entrepreneur has an ease in finding contacts providing substantive expert support in the field concerned. The indicated people are research experts from a university (University of Oulu) and a technical research center (VTT). Contacts in both institutions are provided, including first and last names, e-mail contacts and phone numbers, or even a photograph. All this encourages the entrepreneur – examining his digital maturity, to contact representatives of the world of science. The need to improve cooperation with the world of science is one of topics addressed during focused interviews.

It is important that by contacting experts from the world of science, an SME entrepreneur already has ready information (maturity assessment result, information from the completed SWOT and the Digital Triangle), on the basis of which experts - researchers can make initial decisions regarding further support for the SME, further work with it. Therefore, the Finnish example encourages to educate SME representatives, equips the participant with simple basic analysis tools and easily reduces the barrier of fear among SME entrepreneurs related to anxieties about the need to employ consulting companies.

In order to encourage entrepreneurs to become interested in the digital transformation, stories of companies that have taken transforming actions are also included on the website. The examples describe companies from various sectors at different development phases. They show where the interest in the subject of business digitization came from, what has been its path with the use of ApuaDigiin tools and what benefits the company has achieved. Publication of examples is an extremely encouraging element since it is a typical example of "story telling" (narration with the use of success stories), which is to reduce concerns related to change and convince the parties to use the product. In other words, it is to raise interest in the implementation of proper activities in the context of Industry 4.0. Analyzing the Finnish example, it can be certainly said that ApuaDigiin is a tool supporting SME entrepreneurs, because it is adapted to their expectations and fulfills the educational function.

It was observed in the course of the conducted studies that all countries make the digital maturity assessment model available and the ones made available differ in, among others, the level of feedback. Focused survey respondents emphasized the need to immediately receive the self-assessment result as a key parameter for the effectiveness of the survey. They emphasized

that an active SME entrepreneur highly values their time and cooperation is promising for him or her e.g. when he or she can immediately receive feedback information, on the basis of which he or she will make decisions.

The models from Poland, Finland and Portugal fulfill the criterion of immediate result presentation.

The Portuguese model is also interesting due to presentation of a very comprehensive result. Apart from the graphic attractiveness, attention is drawn by a rich description of recommendations and a summary of questions and answers. Receiving the result in this form, a survey participant will feel that is treated seriously and has used a well-thought and refined tool. In addition, information and education materials posted on the SHIFTto4.0 site as a list of questions, the webinar about starting the digital transformation and the research methodology prove that the model authors treat entrepreneurs' time seriously and professionally and hide nothing from them. This is to have a positive effect on the sympathy from the SME entrepreneur and building good relations in the future. It should be mentioned that in the course of the survey the respondent can check information about their willingness to be contacted on the participation in the survey. Therefore, this is an open incentive to be involved in two-way communication that initially verifies the significance of interest in digital maturity.

Assessing the number and type of the questions and the information collected as well as the great volume of information in the report, it can be concluded that the SHIFTto4.0 model could provide the basis for automatic indication of financing programs.

The last but not least important complementary element of the digital maturity assessment model will be publications of the use cases or success stories related to the implementation of the digital and technological change. The Finnish model can boast of this functionality, where descriptions of other entrepreneurs' success stories have been posted on the website with the materials for digital maturity assessment. Only the Finnish model, apart from the maturity examination itself, presented a narrative promoting use of the digital maturity assessment. The descriptions have the form of short written information.

5. Recommendations for OP Managing Institutions regarding preparation of a digital maturity model for projects dedicated to the development of Industry 4.0 technologies in companies from the small and medium enterprises sector (SME).

During the analytical works being performed, two interviews were conducted, the purpose of which was to acquire suggestions concerning the future digital maturity assessment model for projects dedicated to the development of Industry 4.0 technologies in SME companies. The interviews took place on Thursday, 16 July, and Tuesday, 20 July 2020, and were conducted in the form of a video meeting with the use of the Skype tool. The meetings were attended by the persons who presented very well and from their own experience the perspectives of the world of science, business, innovation centers, technology transfer centers and the intermediary institution. The meeting participants were:

- Scientist1 - Head of the Department, Department of Laser Technologies, Automation and Production Organization, Faculty of Mechanics, the Wrocław University of Science and Technology, Project Manager in one of five Polish Digital Innovation Hubs,
- Scientist2 - deputy DIH Project Manager, also the Department of Laser Technologies, Automation and Production Organization, Faculty of Mechanics, the Wrocław University of Science and Technology,
- Manager - President of the Management Board, Instytut Innowacji i Technologii Politechniki Białostockiej Sp. z o.o. (Institute of Innovation and Technology of the Technical University of Białostok, limited liability company),
- CTT Manager – Managing Director, Centrum Transferu Ekotechnologii Sp. z o.o
- Manager of BTT – Technology Transfer Office at the Medical University of Białystok,

- Business incubator employee (Employee Ink. F) - Acceleration Manager, S5 - 5G Technology Accelerator, Łódź Special Economic Zone,
- Employee of the Intermediary Institution (Employee IP) - Association of Communes and Counties of the Central Subregion of the Silesian Voivodeship,
- Entrepreneur - a manager with many years of experience in capital investment, business restructuring and support for small and medium enterprises, at present being an expert in the Scientific Board of one of science and technology parks.

Each of the asked persons saw the relevance of developing a tool that will help entrepreneurs from the SME sector to examine their digital maturity, however, the survey participants often indicated that the maturity assessment tool itself will change little in the actual adaptation of SMEs to Industry 4.0, because a low interest in this transformation is still visible.

Based on the completed conversations, the following general recommendations could be formulated:

- the key to success of the transition is, first of all, change in the mentality of Polish entrepreneurs and a recognized need for strategic thinking,
- need to educate entrepreneurs in digitization and the benefits involved in the transformation,
- need to show examples of successful digital innovation implementation projects,
- it is worth facilitating acquisition of EU funds to the target group by:
    - application of a digital maturity model, which, apart from maturity assessment, will also indicate the available financing programs,
    - use of the digital maturity analysis report as an appendix to the application for funds and also, as far as possible, use of the model for later evaluation of the project results,
    - maximum possible simplification of the procedures related to the application for funds,
- Industry 4.0 assumes exchange of a huge amount of data between systems and devices, however better communication is also necessary between companies

locally, because this may result in synergies and increased competitiveness of the region,

- The need to build partnerships, in particular business - higher education with participation of the Managing Institution or the Intermediary Institution;
- Need for marketing- and sales-based approach to entrepreneurs.

5.1 Entrepreneur's mentality being the key to success

Interview participants often emphasized that one of the main barriers is the mentality of Polish entrepreneurs and no strategic approach to the development of many SME. No information on the benefits that the digital transformation conveys and the inability to operate within Industry 4.0 results in an aversion to implementing changes. SME managerial staff's focus, who mostly solve current problems or plan for the short-term is not enough to take development actions in a longer time horizon.

When collecting materials for the analysis, some additional conversations were conducted with experienced entrepreneurs. One of the them, a manager with many years of experience in capital investment, business restructuring and support for small and medium enterprises, at present being an expert in the Scientific Council of one of science and technology parks, pointed a couple of times to the mentality of a Polish SME entrepreneur and insufficient education regarding Industry 4.0. At the same this, he confirmed the opinions of the focused interview participants, presented above. This entrepreneur spent a substantial part of his career in the United States, thus, in the context of the usefulness of the digital maturity assessment tool, he attaches very high importance to the ease in its use and the benefits a survey participant must obtain directly after the survey. These benefits can be recommendations, as in the case of the model made available by the Future Industry Platform, however such feedback material is insufficient. An SME entrepreneur, apart from the general slogans regarding the development directions, should obtain specific information on the financing sources available in their case.

One of the survey participants indicated that entrepreneurs in Poland are not ready for the effects of research and development and are not mentally ready for the ninety-nine percent

chance that the research being conducted will fail. According to this participant, a Polish SME entrepreneur is able to calculate very well the efficiency of operation and expects an instant return on the invested funds. Both statements indicate the lack of sufficient education related to a long-term and strategic look at running a business. This gap negatively affects the interest in the benefits from the transition to Industry 4.0. The maturity assessment tool **should consequently examine the business also in terms of the team of persons existing in it who create the action strategy**.

Change in mentality also means that entrepreneurs should know how to deal with employees' fear, as for them the introduction of new technologies may be understood as bearing the risk of loss of the job. Therefore, it would be good if the entrepreneur, with the report about his or her company's digital maturity, received initial information concerning how to communicate to the employees the will to implement changes and introduce new, often automating technologies.

5.2 Need for education about the benefits involved in digitization and need for examples of successful implementation projects

During the interviews the participants indicated that entrepreneurs fear changes because they are not aware of what new technologies and new solutions can offer in their particular case. This was particularly emphasized by Scientist1 and CTT Manager. As both participants represent organizations of different nature, their ways of coping with this phenomenon are different. Scientist1, as the DIH manager and an employee of the Wrocław University of Science and Technology with a huge experience, is able to propose to businesses the possibility to participate in presentations, the possibility to take advantage of advisory services. CTT Manager indicated what can be done more simply and on a larger scale using the digital maturity model. The suggested solution supporting entrepreneurs' education will be **published case studies, success stories of other companies that have already implemented new technologies**, new digital solutions. As an example, CTT Manager mentioned economic zones, which are full of interesting examples originating at least from incubators or acceleration zones. However, he paid attention to the fact that the way of describing them is uninteresting for business managers. The narrative

of this documentation is too extensive, often written in a very complex language. In the age of fast changes and communication using increasingly shorter messages, in the era of the "picture generation", a success case study should be prepared in an attractive way and be easily accessible. The need to mutually inform each other about successful actions was also raised in a statement by Employee Ink.F. Entrepreneurs should have access to good practices of companies from any region and this knowledge should be easily accessible for them, particularly for those who want to check their digital maturity.

According to Scientist1's perspective, across whole Europe there is no proper approach model, which results in the fact that there are no bottom-up initiatives from SMEs. "We are trying to implement the concepts of Industry 4.0 to companies, and the companies [SME – annotation by the report author] defend against this" Scientist1 said. Education of and delivery of information to entrepreneurs is a key element. Scientist2 emphasized missing courage in the management boards and the awareness that the company may obtain interesting business effects at a small expense of work. Here he sees **a major role of a tool for digital maturity assessment** that could show a kind of a "road map", helping to "open the eyes" and set a potential direction of business-wise effective actions.

5.3 Need for facilitating the acquisition of funds

Referring to the use of the digital maturity assessment model, each of the survey participants emphasized, as the expected high-value functionality, the possibility of immediate indication of available financing programs. There is the expectation to integrate information about various forms of support. Usually, entrepreneurs know what programs are offered by the managing institution, it will be valuable to indicate other programs on the national and European level that can supplement the planned project. This will allow for opening new options, arranging project schedules more effectively. The number of financing programs with their different options is so large that entrepreneurs are unable to find the right one for them.

Therefore, it would be good for the entrepreneur, after finishing digital maturity assessment in the context of Industry 4.0, to receive a report specifying the instruments he or she can use. As a matter of fact, entrepreneurs formally can reach out for this information on the

European Funds Site available at https://www.funduszeeuropejskie.gov.pl/, but its method of presentation does not meet to the requirements of the present business. To confirm we are quoting this statement: "*After all, we have funduszeeeuropejskie.gov.pl and there you can find grants, but this is sometimes so incomprehensible or difficult to use that the entrepreneurs who are not expert in the EU funds nomenclature simply give up using this. This is too complicated for a company that has a very simple plan. It wants to implement a new technology, needs funds for this, or to learn whether these funds are available. None of the entrepreneurs we are working with is able to answer what it means that a competition is "unintended for projects implemented in the non-competition mode.[…] None of our customers knows that. He or she has no idea what it means that it is to be entered in the "territorial contract". What is this contract? When to enroll there? Who conducts this? On what terms?".*

The model should be so designed as to ensure that the study report can form a part of the funding application or at least an appendix to the application. It will be a material facilitation for entrepreneurs encouraging them to use the tool. Currently, the difficulty in benefiting from the EU funds lies in the differences in the way the application generators work. Entrepreneurs often get discouraged, because submitting an application to a different Operating Programme requires that they learn how the application is to be completed in a new way and this results in resigning from the support. With a large number of documents to be completed and different formats, a facilitation in the preparation of the application using a digital maturity model will determine its high value. In the course of the interview no proposals of specific solutions and ways to integrate the tool with the Intermediary Institution's requirements were coined, however, a participant indicated that such integration will surely contribute to the attractiveness of the model and would significantly simplify work to the officials.

In context of the ease in completing financial grant applications, one of the participants suggested use of the solutions existing "directly at Brussels" or in the Norwegian Mechanism being available for fifteen years. In this case, the application process is short, takes up to two days and implies submission of an application with the volume of approximately four pages. This will significantly reduce one of the entry barriers, thereby increasing the number of companies applying for support. This change is particularly important, given the existing mental approach of the entrepreneurs. **He encouraged to reflect on this innovative way to simplify the application**

process. He paid attention to the fact that the European Commission does not impose procedures and requirements, they are created on the local level. He encouraged to look at how the application processes and the applications looked like in the 6th Framework Programme, 7th Framework Programme, the Norwegian Mechanism and the Swiss Program. He paid attention to the possibility to move the amounts across particular budget items and communicate with the financing institution. "*This is night and day*" he said in the end.

5.4 Need for mutual communication

Another problem raised by the survey participants was the problem of communication with entrepreneurs. The communication is a very broad problem and the survey participants put a particular focus on the following:

- communication with a potential beneficiary (reference was made here to the speed of answering and facilities for finding the right information),
- communication between companies (the report from the conducted maturity assessment would simplify contacts with companies which can boast of successful implementation projects in the context of Industry 4.0),
- communication between SMEs and universities (the model should examine and assess SME's level of involvement in cooperation with representatives of the scientific sector),
- direct communication with entrepreneurs, under which it is worth contacting an entrepreneur who has used the model and assessed their maturity.

The topic of direct communication with a potential beneficiary is quite a complex issue where the so-called "chemistry" plays a big role and this is an element which is not quantifiable. Further project steps depend on the "chemistry", being a way to customarily express the quality of communication, also between business partners. Whatever the assessment model used, it may serve as a screening tool. In genuine support for SMEs "*nothing will replace close cooperation*".

Any possible further common actions of the entrepreneur with the financing institution require detailed interviews and, only based on those, useful conclusions and planned implementation projects can be developed. Scientist2 was talking about this, coordinating cooperation with more than thirty companies linked within Digital Innovation Hub (DIH) at the

Wrocław University of Technology. These hubs are formally obliged by Platforma Przemysłu Przyszłości (Future Industry Platform) Foundation to apply the digital maturity assessment model made available by FPPP, earlier described in this report. However, this tool collects too little information to help the given SME in development. Further communication with the SME is required, often meaning consulting actions.

Direct communication with an SME entrepreneur means e.g. contact with a user who has completed the survey using the digital maturity model. This contact would be intended to ensure that this entrepreneur is important for the financing institution. During the contact, it will be possible at least to thank for using the model and ask about possible impressions, encourage to contact further. From the point of view of a survey participant, such pro-active initiative may be an incentive to continue further development actions in the context of Industry 4.0 and will surely positively affect the image of public administration and encourage to think about taking advantage of the support.

Another suggestion was a repeated contact from the Managing Institution or the Intermediary Institution established with the entrepreneur at a fixed time after completing the first survey. The purpose of the second contact would be to remind about the completed survey, ask about any change of the perspective since the time of the survey conducted and encourage again to contact.

It is also worth taking a step further and analyzing the questionnaires collected by the model. As in the context of Industry 4.0 reference is made to technologies such as BigData or Business Intelligence assisting in obtaining knowledge from pure data, according to the survey participants it seems right to make basic analysis of the data coming from the model. They may assist in formulating conclusions among which entrepreneurs the promotion should be pursued, what problems they are facing, what issues are most frequent. It is worth using analytical support from higher education schools.

5.5 Need for drawing attention to and promoting new partnerships

Industry 4.0 involves the requirements for close cooperation between stakeholders, which has earlier been discussed in this study. But before an idea turns into an innovation, namely

before it is commercialized, an earlier stage of research and development is necessary. On the other hand, this one requires a closer cooperation between the entrepreneur and the university. According to the survey participants, universities have opened for cooperation, a problem is still the conviction about unchanged approach at universities prevailing among SME entrepreneurs. The participants emphasized that, apart from the digital maturity assessment itself, the benefits resulting from cooperation with universities and success stories of such cooperation cases should be communicated to the examined businesses. In addition, the will should be evaluated not only to cooperate with universities but in general to join public-private partnerships. It was suggested that regional information portals should be created, connecting entities interested in using Industry 4.0 tools with organizations offering such solutions. The third participant in such a website are to be universities, whose responsibility would be to issue "something like a certificate of rationale for the implementation of a particular solution". Reference was also made to the need that the scientific entity prepares a kind of feasibility and implementation analysis. It was also suggested that the cooperation: local government – business – universities and business environment institutions should be closely tightened. Autonomous actions will not offer benefits both when implementing a technology or when acquiring funds. "*We will not be able to speak about sustainable development but only about competitive development*"– a survey participant summed up.

5.6 No coercion, just incentive

During the interviews the participants a couple of times drew attention to the fact that the digital maturity assessment model can be a very interesting tool promoting Industry 4.0 and the support that can be obtained to transform the business to its requirements. It should be approached in the same way as a marketing product, care about its attractiveness and analyze data it will collect from the market.

5.7 CONCLUSIONS AND INITIAL RECOMMENDATIONS

Based on the information obtained during focused interviews and referring to the working definition of the digital maturity problem, it can be definitely concluded that the challenge on the path to SMEs' transformation to Industry 4.0 and consequently also to the support for innovation is the potential of the human capital. Here, reference is made particularly to the management staff because the members of this group initiate changes and make the respective strategic and operational decisions.

The so-called human factor has been mentioned many times as a barrier to the transition and implementation of digital innovations. The most common related restrictions are the SME entrepreneur's mentality, unsatisfactory education on the opportunities and benefits from the implementation of digital innovations and too weak awareness of the interdependencies, and too weak communication between the market elements being SMEs, universities, financing institutions.

The problem of education about the benefits from the transition is also emphasized in the study quoted at the beginning "Digital competences of Polish small and medium enterprises". An important role in increasing the awareness about the values involved in the digital transformation will be played by "Showing specific, measurable benefits from the introduction of digital technologies to the SME sector such as: increased work effectiveness, possibility of expansion into new markets, increased profit and development potential"[30] . Further, researchers from the University of Warsaw indicate that, for entrepreneurs and employees, it will be of high importance to break the conservatism and "learned ineptness" with reference to digital technologies. This can be achieved by putting pressure on the simplicity of using them and the sense in their application. Motivating to gain new skills and digital competences, both on one's own (self-education) and in the form of convenient, inexpensive training adapted to the needs of the SME sector from different sectors of the economy.

[30] K. Śledziewska, R. Włoch "Kompetencje cyfrowe polskich małych i średnich przedsiębiorstw", DELab Warsaw University, 2015, op.cit.

Barriers related to the formal requirements concerning financing from operating programs can be clearly noticed in the background. The SME entrepreneurs have often no sufficient resources in the company to analyze the available financing options and fight for the acquisition of financing. The SME entrepreneur's mentality disposes him to engage in the operating battle for maintaining its market position. No suitable education and the need to fulfill permanently changing legal conditions makes strategic thinking, necessary for the transition and long-term implementation of innovations, a lower priority activity in the eyes of the SME entrepreneur, being moved to the background or abandoned at all. For this reason, it is so important to equip entrepreneurs with a tool that will fulfill the educational function, simultaneously being very simple in use. Here, an example may be Finnish ApuaDigiin.

On the basis of the source materials from the Finland partners we can see that their tool still does not have the functionality that indicates the suggested source of financing under Operating Programs. The partners from Finland want to make this functionality available soon. However, before this happens, it is important that a Finnish entrepreneur sees right away the possibility to initiate contact with representatives of the world of science, indicated by their first and last name. Such an approach supports communication between business and universities as well as supports partnership building. Good communication lies at the core of the digital world, while partnerships effectively increase the efficiency of implementing innovations.

SME entrepreneurs live in a rapidly operating world, delivering more and more ready-made suggestions and choices. SME entrepreneurs have the same expectation from the tool that potentially has to help them to introduce the company with its technologies and human resources to a higher level of development.

6. Summary

The purpose of the completed analysis was to find and define the requirements that should be fulfilled by the digital maturity assessment model for a SME enterprise in order to become a tool enabling support for the company in the digital and technological transformation in

connection with Industry 4.0. Selected digital maturity assessment models developed at different times and in different countries as well as models used by INNO PROVEMENT project partners have been analyzed.

The subsequent chapter includes information about the models used by INNO PROVEMENT project partners, which is a very interesting comparison of the ways to apply theory in practice. The completed analysis has demonstrated a great diversity in the level of advancement when applying the models for digital maturity assessment. In the INNO PROVEMENT project group, the examples of application of very well developed models (Portugal, Finland) balance the examples where the models are working in a very simple manner (Czech Republic), or are still to be developed (Greece, Italy).

The models made available in Finland and Portugal can be considered the most interesting among the models examined. Both of them assume an open approach to an entrepreneur and instant provision of the assessment with possible further digital transformation on the basis of the obtained results. The report results are only guidelines and suggestions, and not a specific operational plan, yet they help the entrepreneur to understand the tasks he or she will face on the way to Industry 4.0.

Regardless of the technology chosen for the construction of the model and how detailed questions have been provided, the effectiveness of any tool is determined by the human factor. This main conclusion was drawn from the study conducted with representatives of the institutions responsible for the distribution of funds, university representatives as well as representatives of business and knowledge transfer and innovation implementation support organizations. Apart from university representatives, experience and suggestions were shared by experts working every day with SMEs, supporting them in the effective implementation of change, obtaining funds or increasing the operational efficiency. They included CEOs in technology transfer centers, an accelerator manager. Certainly, it can be assumed that the suggestions provided are to guarantee real support for the development of digital and technology innovations in the context of Industry 4.0.

The key to the proper support for SMEs in increasing digital maturity and implementation of new technologies in the context of Industry 4.0 is the mentality of a Polish entrepreneur from

a small and medium enterprise. This mentality is affected by many factors, from the business environment, to legal conditions of operations, to education and awareness among the management staff. **No strategic approach to SME management and no knowledge about the benefits from the application industry 4.0 solutions contribute to a small interest in acquiring support for this development direction. Using the business language, it may be stated that SME entrepreneurs "do not buy" development towards Industry 4.0, the problem is not attractive enough for them or the barrier is the lack of knowledge about it.**

In this context it is worth reminding the words of Minister Emilewicz: "*The transition to Industry 4.0 is a long-term process, requiring change in many areas. What is necessary is a suitable strategy, acquisition of new competences, staff training and finally implementation of selected solutions in the company*". Thus, the key aspects are time and staff competences, while the technologies being implemented are only a derivative of the company's needs. The company's needs must be defined by nobody else but competent staff.

Remembering the comments and recommendations of the focused study participants, one should take a particularly careful look at two models – Finnish "ApuaDigiin" and Portuguese "SHIFTto4.0". Both models pass a list of recommendations in order to facilitate the digital and technological change, though both do it differently. The Portuguese model is very well parameterized and, based on the German model "Impuls – Industry 4.0 Readiness" already developed since 2015 by the federation of engineers and business representatives, delivers very rich feedback to the survey participant. Among the models examined, Portuguese SHIFTto4.0 is distinguished by the most comprehensive feedback.

The second model worth attention is Finnish ApuaDigiin. It is characterized by:

- Scandinavian simplicity of operation taking account of such elements as language of communication and graphics,
- educational value demonstrated by tools useful in managing their companies being made available to the entrepreneurs,
- adjustment to the requirements of seniors rather than the generation of the young computerized market participants,

- self-promotion in the form of descriptions of digital transformation success stories,
- information value showing how the digital maturity assessment result of a business relates to the results of other companies operating in the same industry,
- an incentive to initiate contact and discuss the result and the company's situation with representatives of the world of science and the technical organization.

It must be noticed that many of these typical characteristics are the same as the requirements of business people, which have been expressed by the interview participants, and summarized below.

The digital maturity assessment model existing in Poland made available by the Future Industry Platform was not commonly known to the survey participants, thus they were unable to refer to the usefulness of the tool.

In the course of the analysis and on the basis of conversations with the survey participants, it could not be determined how the models are to obtain information about available European funds. The analysis did not cover the method of integrating the information obtained by the maturity assessment model with the available information on support programs. Regardless of whether and how the useful maturity assessment model will be connected to the Central IT System or e.g. the information database of the Smart Development Operational Programme, its usability will determine the popularity of the tool. Thus, it is worth thinking not only about the functionality of the model for an entrepreneur and for the Managing Institution, but also about proper presentation of the product that the digital maturity model will undoubtedly be.

Regardless of the digital maturity assessment model used, care should be taken to ensure its attractiveness for SME entrepreneurs and its informational function. The digital and technological transformation in the context of Industry 4.0 will happen only when the entrepreneurs see benefits in it and it is understandable for them.

Therefore, the Managing Institution or the Intermediary Institution, in order to increase the effectiveness of support for implementing innovations, should become an advisor, an educator for SME, and promote its services in this group. Financial support from Operating Programs should also be regarded as a product, which needs a suitable educational campaign

among the target group in order to better manage recipients' expectations, explain the problem in a simple way, show the benefits and examples of successful implementation projects. This will break SMEs' objections and encourage strategic thinking and reaching for support for the implementation of innovation related to adjustment to Industry 4.0.

Based on the information collected in the analysis, it should be indicated that, from the point of view of the Managing Institution, the elements that will have the greatest effect on increasing the number of innovations supporting the transformation to Industry 4.0 are the following:

- increased awareness among SME entrepreneurs about the need for digital transformation in the context of Industry 4.0 by:
  - education of target group in Industry 4.0 and the changes this industrial revolution will cause in the future,
  - presentation of the benefits that are involved in the broadly understood digital innovations,
  - presentation of success examples from different countries and different industries, in order to show the actual benefits from the transformation and in order to help the entrepreneur to identify with another business having a similar profile or target markets.

    Education and presentations can be conducted with the use of electronic tools (e.g. Platforma Przemysłu Przyszłości (Future Industry Platform) or the portal focused on the needs of the Łódzkie Voivodeship). Direct contact with entrepreneurs during presentations will also be recommended (guest presence at thematic conferences or other meetings of entrepreneurs such as business boards, business clubs, industry organizations, fairs) and roadshow events. Communication with entrepreneurs should clearly emphasize the critical role of partnerships with the world of science. An SME entrepreneur is to be encouraged to take a step further and talk with representatives of science and the Managing /Intermediary Institution about the opportunities Industry 4.0 creates for his or her company. The purpose of such of the meeting is not to provide a consulting

service for the entrepreneur, but to initially examine his or her needs and find a common point. Perhaps a good solution will be establishment of a permanent consultation point at one of the business centers.

From the point of view of interest of SMEs in the Łódzkie Voivodeship in the transformation to Industry 4.0 it can be justified to obtain information from the Platforma Przemysłu Przyszłości (Future Industry Platform) Foundation, which companies from the Łódzkie Voivodeship have used the digital maturity assessment model. Contact with representatives of such companies may significantly raise the effectiveness in the distribution of EU funds. There is a great possibility that education about the value of the transition to Industry 4.0 in these companies is already at a higher level and there is a real interest in the use of EU funds.

- After increasing the awareness and interest in the acquisition of financing among entrepreneurs, it is time to submit an application. Based on the conducted analysis, the recommendations are the following:
  - Submission of an application should be simplified as far as possible,
  - The selected digital maturity assessment model should include information that will be evaluated in the application; this will simplify work for the entrepreneur and make subsequent evaluation easier for the Managing/Intermediary Institution (after the agreed time the entrepreneur fills in an application known to them, it is easy to compare the answers provided; an example may be the scope of answers included in the Portuguese tool),
- Self-promotion
  - The acquisition of financing should be based on the entrepreneur's readiness to initiate a partnership with representatives of the world of science and their consent to the publication of information about valuable effects of the transition.
  - Participation in the project and use of the EU support should involve the need for developing an implementation example and providing the consent to its

publication. With this, the Managing Institutions/Intermediary Institutions will in a way automatically obtain the marketing material, used for further promotion of the subject area. These examples should be competently prepared by an external partner, which will wrap them in an identical template, format and will care for the quality of the narrative. As not every implementation project is ended successfully and, consequently, the company will not want to publish this information, it is necessary that the professional communication partner is able to choose and develop proper examples and the beneficiaries express their consent thereto.

To sum up, the Managing /Intermediary Institutions have great experience in the distribution of EU funds, monitoring their correct spending. It results from the completed analysis that potential fund recipients are not even aware that they need or will need them. Therefore, both institutions face a huge challenge to enlighten SME entrepreneurs, change their mentality and reduce the concerns related to the unknown being the set of changes related to Industry 4.0. The next stage will be facilitation in applying for EU funds. Such a project requires strategic decisions, among others about partnership-based cooperation with universities and about simplification of the procedures. An SME entrepreneur from the Łódź Voivodeship will appreciate this effort of the state institutions. Trying to stay on the market and develop, he or she may need support in encouraging strategic development, raising the awareness of the needs as well as support in starting the digital transformation path to Industry 4.0. After all, there are already publications about Industry 5.0, which will be characterized by cooperation between robots and people. Although such change will not happen immediately, already now it is worth preparing mentally SME entrepreneurs from the Łódź Voivodeship to new challenges. [31]

[31] M. Krill "Industry 5.0 – networking między człowiekiem a maszyną", https://polskiprzemysl.com.pl/utrzymanie-ruchu/industry-5-0/, [access: 10.08.2020]

7. List of figures

7.1 List of figures