AN EMPIRICAL STUDY OF DIGITAL COMPETENCES AND REQUIREMENTS OF BULGARIAN MANUFACTURING SMEs

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***Key words:** Industry 4.0, Lean 4.0, Digitalization, Small and Medium-Sized Enterprises (SMEs).*

***Abstract:** In the present publication, a study of Bulgarian SMEs learning needs and requirements in the field of Industry 4.0, digitalization and Lean 4.0 principles is presented. The main objective of the survey is to provide a comprehensive basis for elaborating an adequate and helpful learning program to enable SMEs to successfully implement and use the basic pillars of Industry 4.0 and Lean Manufacturing. The present survey is a part of a bigger one, performed under an EIT Manufacturing project titled "Skills for digital transformation of manufacturing empowered by Artificial Intelligence and Lean 4.0".*

INTRODUCTION

This survey was conducted as part of an **EIT Manufacturing** project *"Skills for Digital Transformation of Manufacturing Empowered by Artificial Intelligence and Lean 4.0" – AIskills4Lean*.

The main academic partners in this project are: Technical University of Vienna (TU Wien) – the project leader, University "St. St. Cyril and Methodius" – Skopje and Technical University of Sofia (TU-Sofia). The main objective of the AIskills4Lean project is to provide organizations in South-East Europe with the knowledge needed to successfully integrate Artificial Intelligence (AI) and Lean 4.0 principles into their manufacturing work systems.

One of the basic work packages of the project is aimed to study the state of the art and learn about the Bulgarian and North Macedonian SMEs' needs in the field of Industry 4.0 with a particular focus on Lean Manufacturing and Artificial Intelligence. In order to fulfil this objective, a broader questionnaire was developed, covering areas, such as:

- Ongoing digital transformation and Industry 4.0 components implementation status,
- Lean 4.0 principles,
- Integration of the Artificial Intelligence (AI), such as Voice Assistant Systems (VAS) use in managing company operations, providing the information necessary for task execution and mistake reduction while simultaneously gathering crucial data related to the production process.

In addition, the aim of the present paper is to focus on the first two bullets, concerning Bulgarian SMEs.

1. RESENT RESEARCH IN BULGARIA

1.1. Project RESTART 4.0 – Digital Training Toolbox to FosteR EU'S IndusTry 4.0 RevoluTion (https://restart-project.eu/)

A report for Bulgarian Industry with the main conclusions of the 2018 Survey of Digital Technologies in Industry 4.0 in Bulgaria is presented by RESTART 4.0 [1]. Partners from Spain, Italy, Scotland, Greece, and Malta also conducted a survey to establish the initial digital business assessment to capture the level of digital skills among local and national companies and to measure the level of digital skills of staff in each country. This training needs report is designed to explore both the use and perception of digital technologies and e-skills and the benefits of digital technologies through training in traditional industries with a view to the growing portfolio of services, products and manufacturing in each of the partner countries in the project.

Among the main conclusions of the analysis, which are actual enough nowadays, are following [1]:

- The level of Vocational and Education Training (VET) for digital skills varies widely across project partner countries;
- There is a gap in digital VET consisting of available training and employer needs;
- VET for digital skills also varies significantly by manufacturing sector;
- Regular workers have less formal digital qualifications;
- Many businesses (30%) report difficulties in hiring better trained employees;
- Larger enterprises provide their employees with a higher level of training related to digital skills;
- Digital learning is not meeting demand needs;
- Great importance, both at the national and international level of competitiveness, is attached to the results of digitization;
- Digitalization would increase productivity in most engineering and manufacturing firms/enterprises;
- There is a huge demand for employees to acquire digital skills at every level;
- **Demand for digital training is mostly in SMEs;**
- Through improvements in their processes, companies are required to invest less and achieve higher productivity;
- There is a mismatch between demand and supply of the necessary digital skills;
- Enterprises and firms still report a low level of digital competencies.

1.2. Bulgarian Industrial Association

Bulgarian Industrial Association (BIA) is one of the small number of Bulgarian institutions that have made and posted recent survey(s) in the field of digitalization progress of manufacturing companies – both large ones and SMEs. On its site https://digital.bia-bg.com/en/analyses/roundtable/, BIA has posted such surveys in 16 different industry sectors in Bulgaria. Concerning the attitude of the present publication, a particular attention is worth to be placed on the training needs analysis of the companies from the following sectors: Manufacture of Electrical Equipment, Manufacture of Basic Chemical Substances and Manufacture of Transport Vehicles and Equipment.

1.2.1. Manufacture of Electrical Equipment Sector

The study of Bulgarian Industrial Association [2] shows that the enterprises from the sector will need the most industry and production automation specialists (according to 86% of the participants), and digital marketing specialists and conceptual planning specialists and implementation (57% of participants). According to the number of employed of enterprises in

the Manufacture of Electrical Equipment sector, only about 4% of the companies are large enterprises, and the rest ones are small and medium-sized enterprises (SMEs). Although companies are aware of the realities and that the need for digitization is a fact, there is a significant difference between the implementations of digital technologies among different companies. While large enterprises are the engine of digital transformation and they not only create, but also successfully integrate new technological solutions, SMEs encounter more difficulties due to lack of financial resources, as well as lack of capacity and there is a sensitive deficit in the necessary digital skills. Despite these difficulties, during the last year, there has been a tendency to perceive digitization as a key priority from SMEs. By number of specialists with digital competences, the level of Bulgaria is much lower than the EU average [2].

1.2.2. Manufacture of Basic Chemical Substances Sector

The survey used questions from a survey on the level of digitization in Bulgaria, carried out jointly by Siemens Bulgaria and the German-Bulgarian Industrial Trade Chamber during the period June-July 2021 [3].

To the question „What do you think will be the benefit of digitization for the achievement of the listed corporate goals?" the majority of the respondents pointed the answers that are in line with the present paper priorities/targets:

- More efficient gathering and analysis of information (90,2%);
- Improved customer service processes (80,6%);
- Better planning and management (74,2%) and
- Improving the speed of operations (71%).

And the "Insufficient qualifications and skills of employees" were assessed as the main difficulty for introducing new digital solutions in enterprises (83,9% of the respondents consider it true or somewhat true). Also, it is pointed that the specialists in the field of Industry 4.0 and automation are the most needed ones in the coming years (64,5%). While the second most-needed ones are Business analysts, far behind at 38,7% [3].

1.2.3. Manufacture of Transport Vehicles and Equipment Sector

According to [4], in the Transport Vehicles and Equipment Sector, overall, most employees do not master the core competency areas (from 25 to 36%) or master them at a basic level (from 25 to 36%). At an average level, 18 to 21% of employees master the areas of competence, at an advanced level – from 11% to 14% of employees, and at a highly specialized level from 4 to 7% of employees.

According to the survey, the enterprises of the sector in the next five years will need the most industry and automation specialists manufacturing (according to 67% of respondents), business analysts, computer engineers and technicians and hardware engineers (according to 33% of respondents). What employers from the sector also share is a shortage of qualified personnel with digital competences. In particular, the ability to simultaneously use multiple technology products and interconnect/multitask between them. It is necessary to train employees in digital skills on the one hand, and on the other hand to educate them about the usefulness of technology to achieve optimal business results. And according to about 50% of the respondents who took part in the survey, the level of digitization of enterprises in the sector is at a "moderately low level" of digitization, about 28% of them are at a "low level" and about 20% are at a "moderately high". Only about 3% of enterprises consider themselves to be at a high level [4].

1.3. Summary

In Bulgaria, there are not many significant developments during last 3 years on a national level, mainly due to the political situation in the country. The conditions and characteristics in regard with the main research question of the current report, namely: "What are the digital competences and learning needs in the field of using AI and Lean in the

manufacturing operations?", remain poor and at an insufficient level – in general terms – the way they have been described in above surveys.

According to surveys cited, one could make the following conclusions about the digital competences in the Bulgarian manufacturing enterprises, and especially for the SMEs:

- The greatest need of manufacturing companies is declared to be for specialists in the field of industry and production automation (on an average of 70-80 % of respondents);
- "Insufficient qualifications and skills of employees" was stated by more than 80% on average;
- Rapid and widespread digitization has changed the nature of work, making digital skills one of the essential skills for the modern workforce.

2. STUDY OF DIGITAL COMPETENCES REQUIREMENTS OF BULGARIAN INDUSTRIAL SMEs

As mentioned in the introduction, the present survey is a part of a bigger one, performed under an EIT Manufacturing funded project titled "Skills for digital transformation of manufacturing empowered by Artificial Intelligence and Lean 4.0" (AIskills4Lean). In the survey, Bulgarian and North Macedonian companies (mainly SMEs) have been interviewed via Internet – Google Forms. Herewith enclosed, an evincible part of the study and conclusions are presented.

2.1. Company Profiles

Twelve of the enterprises, which answered the questionnaire, were Bulgarian. According to definition of European Commission Recommendation 2003/361 for the size and economic weight of enterprises, more than 91% of the Bulgarian companies interviewed are SMEs: 2 of them are Micro-, 3 – Small, and 6 are Medium-sized enterprises. All of them are in the manufacturing sector.

2.2. Industry 4.0, Digitalization and Lean 4.0

In general, the nine different pillars of Industry 4.0 are of somewhat "evenly dispersed" importance – Figure 1:
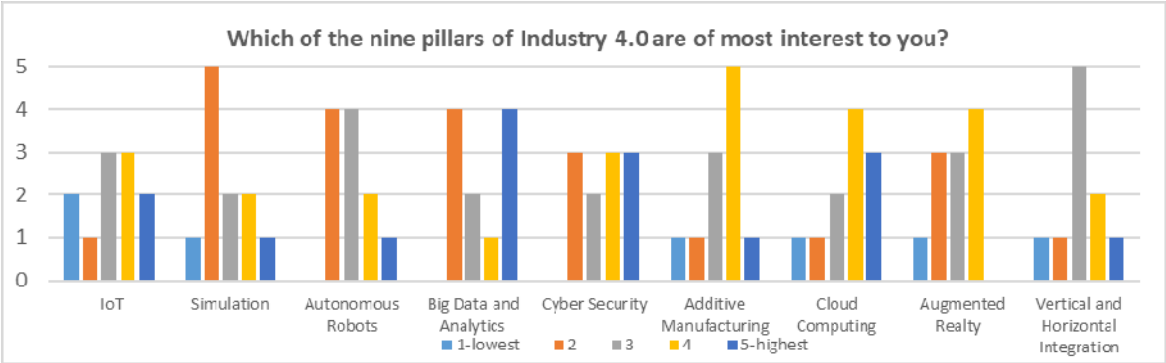

Figure 1. Question: Which of the nine pillars of Industry 4.0 are of most interest to you?

Nevertheless, IoT, Big Data, Additive Manufacturing and Augmented Reality are of the highest interest among the others.

However, only 45% (5 companies out of 11) have already implemented projects on digital technologies (thoroughly or partially). Among them, 4 use integrated software solutions (ERP/ PLM etc.) and one – office solutions with defined processes (e.g. approval processes with corresponding format templates) – Figure 2. Also, 36,36% are planning to do something, and 18% (2 companies) have even not planned anything yet.
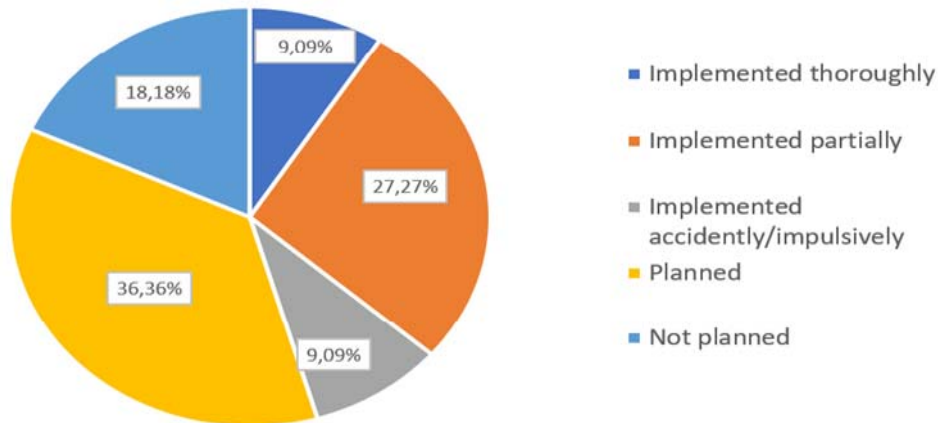
Figure 2. Question: How would you describe the status regarding the digitalization in your company?

And, looking at the big picture, one could conclude that only those companies, which have already implemented ERP systems, have really done a more significant step to the real integrated digitalization of business processes and production/manufacturing operations, although all of them use digital technologies in one sphere or another (Figure 3):
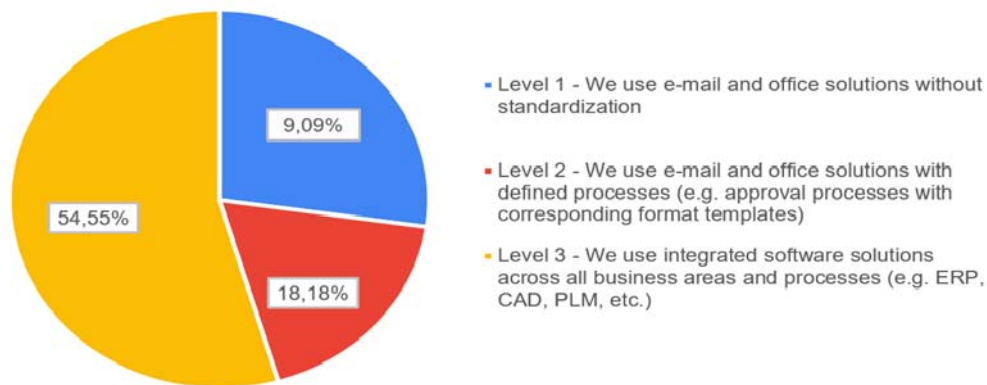

Figure 3. Question: To what level are your business processes digitized and standardized?

Currently, the most of the companies that have implemented digital solutions (72,7%), use the production related data generated for performing planning-process or controlling-process monitoring (Figure 4):
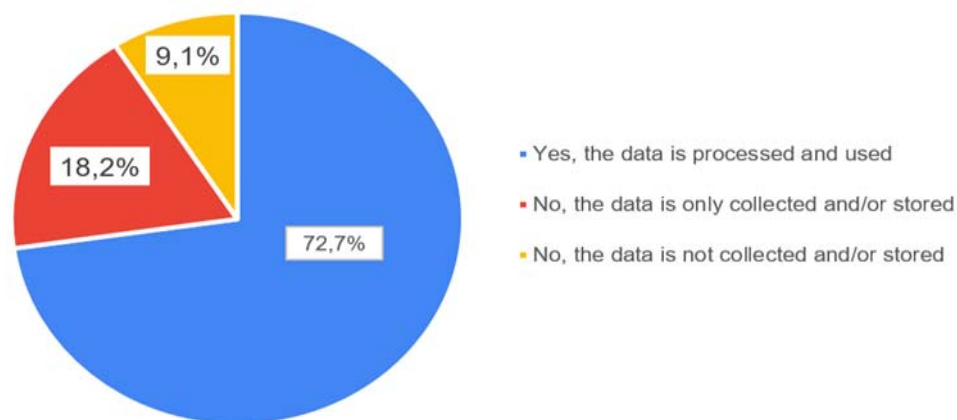
Figure 4. Question: Is the production related data generated in your company processed and used for processing planning-process or controlling-process monitoring?

Also, the companies are unanimous about the strengths and advantages of digitalization (Figure 5). More than two thirds of them are aware that operations will be

improved significantly: 36,4% are convinced that digitalization leads to increased productivity and another 18,2% – to cost savings. Also, the beneficial influence on the customer relationship will be a good result achieved: more than 36% know that the customer satisfaction and faster time-to-market (the latter is an operations achievement too):
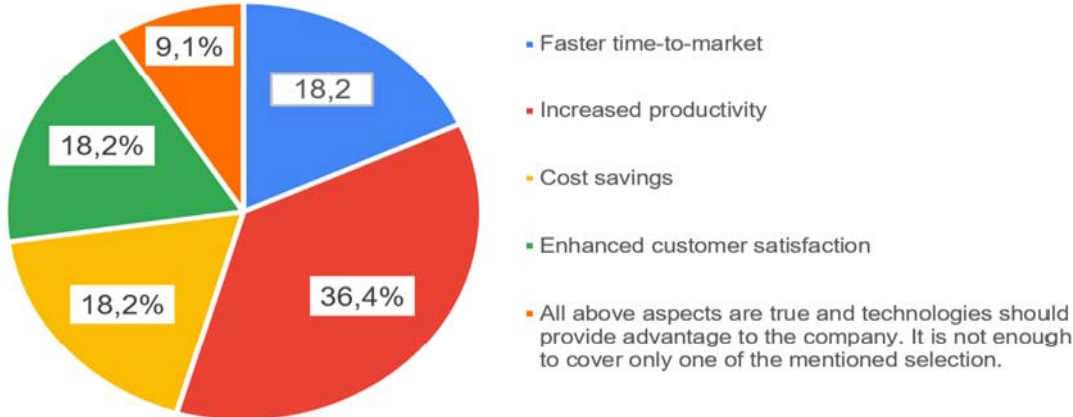

Figure 5. Question: How do you measure the impact of digital technologies on your company's performance?

Regarding training and qualification services, 36,4% of the companies use external providers, 27,3% use in-house specialists, and the one thing to be concerned of is that 36,4% of the companies don't offer any (Figure 6):
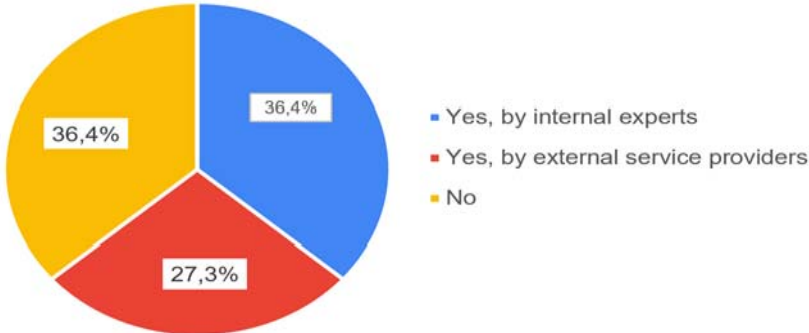

Figure 6. Question: Does your company currently offer qualification services, trainings, competence development regarding digital technologies for your employees?

To add to the above, the level of employees' qualification in the field of application of digital technologies is not too high – the estimate keeps a middle value across the different operations knowledge areas (Figure 7):
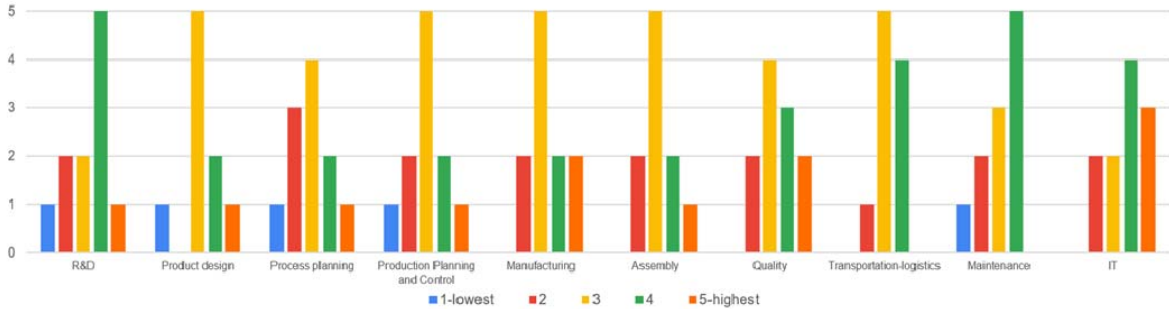

Figure 7. Question: How well qualified are the employees in your company regarding to the application of digital technologies?

To help with this, the following question is meant to address the development of training programs targeted at digital competences improving and upgrading (Figure 8):
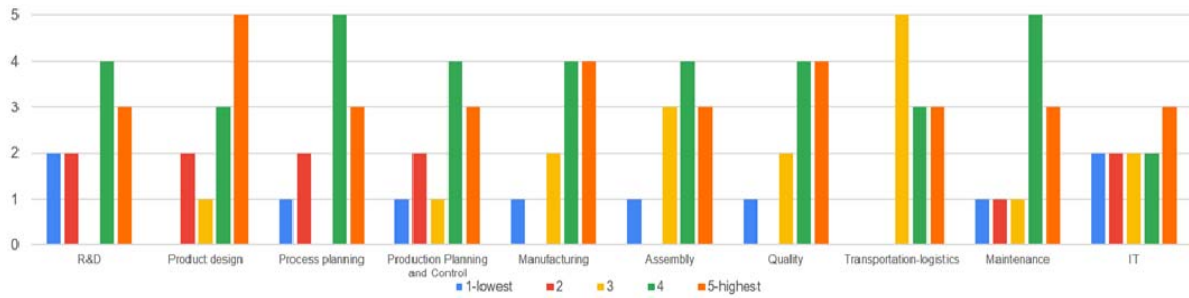
Figure 8. Question: In which areas of your company would competences regarding digital technologies be required?

Obviously, the companies need more training focused in the fields of operations (the assessment scores in the areas of Research & Development, Product Design, Process Planning, Production Planning and Control, Manufacturing, Maintenance and Quality are oriented mostly to 4th and 5th degree – the highest ones). And in the areas of Transportation and IT the estimation is dominantly in the middle.

Among the respondents' comments, the following details are worth to cite:

- Production Management / Supply Chain Management lack enough competence;
- In production and assembly, we need to improve our digital qualification to be able to eliminate mistakes (pick to light, robots), improve quality and improve productivity (MES);
- Information technology and cybersecurity.

Having in mind above, according to the respondents, the following are the qualification trainings needed (Figure 9):
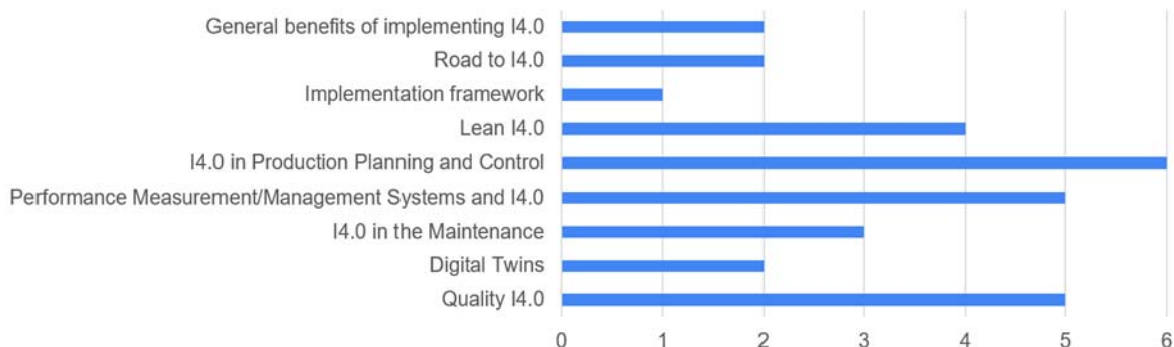

Figure 9. Question: Which of the following aspects seem suitable for training in your company?

Again the focus is on the digitalization in Operations Management: Production planning and control was pointed out by 6 companies (55%). Apart from this, the following particular components of Production planning and control were especially specified: Lean 4.0 – by 4 companies, PMS – by 5 and Quality 4.0 – again by 5 companies. The use of Digital Twins is still not that much of interest among the SMEs.

3. CONCLUSION

The survey presented in this publication, although performed among not so big number of companies to be representative enough for Bulgarian SMEs, is indicative enough to show their specific learning needs and requirements with regard to Industry 4.0. The issues discussed here, are common for the Bulgarian economy and are confirmed by much more representative research conducted in Bulgaria during recent years, especially in the field of Industry 4.0 and digitalization [2, 3, 4].

According to the results of the survey, the biggest training needs and requirements of

Bulgarian manufacturing SMEs is in the field of Production/Operations Management:

- Production Planning and Control in general, and in particular
- Lean 4.0,
- Performance Management Systems in I4.0,
- Quality 4.0 and
- Total Productive Maintenance.

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ЕМПИРИЧНО ИЗСЛЕДВАНЕ НА ДИГИТАЛНИТЕ КОМПЕТЕНТНОСТИ И ПОТРЕБНОСТИ НА БЪЛГАРСКИТЕ ПРОИЗВОДСТВЕНИ МСП

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Ключови думи: *Индустрия 4.0, Лийн 4.0, Дигитализация, Малки и средни предприятия (МСП),*

Резюме: *В настоящата публикация е представено изследване на потребностите и изискванията на българските МСП от обучение в областта на Индустрия 4.0, дигитализацията и принципите на Lean 4.0. Основната цел на проучването е да осигури изчерпателна основа за разработване на адекватна и полезна програма за обучение, която да позволи на МСП успешно да внедрят и използват основните стълбове на Индустрия 4.0 и Lean производство. Настоящото проучване е част от по-голямо, проведено по проект на EIT Manifacturing, озаглавен „Умения за дигитална трансформация на производството, подпомогнати от изкуствен интелект и Lean 4.0".*