



ANALYSIS AND PERSPECTIVES OF THE LEVEL OF ENTERPRISES DIGITALIZATION (LITHUANIAN MANUFACTURING SECTOR CASE)

Daiva Bickauske

Mykolas Romeris University, Lithuania

E-mail: daiva.bickauske@gmail.com

Zaneta Simanaviciene

Mykolas Romeris University, Lithuania

E-mail: zasiman@mruni.eu

Arturas Jakubavicius

Vilnius Gediminas Technical University, Lithuania

E-mail: arturas.jakubavicius@vgtu.lt

Mantas Vilys

Vilnius Gediminas Technical University, Lithuania

E-mail: mantas.vilys@vgtu.lt

Larysa Mykhalchyshyna

National University of Life and Environmental Sciences of Ukraine, Ukraine

E-mail: larysam@nubip.edu.ua

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ABSTRACT

The impact of technological advances in all industry sectors is being felt and, thus, there is no doubt that digital transformation will have significantly affect Lithuanian manufacturing sector. In order to assess the extent to which Lithuanian processing industry companies are digitalized, an in-depth descriptive analysis of installed digital technologies in these companies was executed. The goal of this analysis – to determine whether Lithuanian companies of processing industry has been sufficiently digitalized and are ready to completely adopt the principles of Industry 4.0 in the installation of digital solutions within all segments of the value-chain creation. The research on already-applied digital tools and technologies in those companies was made during the phase of analysis. There was also an attempt to define the most digitalized processes of operation and the least or non-digitalized processes of operations in those companies. After the assessment of a current digitalization level in the company was made,



there was an attempt to clarify the strengths and problematic challenges as well as the underlying reasons for its challenges. After the above-mentioned data was collected, recommendations on which additional tools and means to apply in order to encourage the process of digitalization in the companies were formulated and passed on to the companies.

Keywords: digitalization; manufacturing; digital technologies; digitalization level

1. INTRODUCTION

European Commission (2017) underlined the importance of a strong and high performing industry for the future of Europe's economy, and the need to bring industry's weight in the EU GDP back to 20% by 2020. European Parliament states that 80% of all innovation and exports comes from industry, as do many jobs and for that reason, the main focus of EU policies must be strengthening Europe's industrial base. Despite efforts, Europe's role in the global data and platform economy is limited and the uptake of digital technology by SMEs is low: 90 % of SMEs and 60% of large companies are lagging behind (BERGER, 2015).

There is no doubt that digitalization has been completely revolutionizing the present era and digital transformation is expected to have a vast impact on almost any industry. It can bring new opportunities for SMEs by improving the entire value chain (KILIMIS, 2019). In scientific literature, authors emphasize the importance of industry digitization (WANG, 2016; QIN; LIU, 2016). They state that companies need to implement the latest technology. Digitalization will have a monumental impact on the global economy, so vast and multifaceted that it makes it hard to disentangle one particular effect from the next (SCHWAB, 2016).

Digitalization can be defined as a “a change in all job and income creation strategies, application of a flexible management model standing against competition, quickly meeting changing demands, a process of reinventing a business to digitalize operations and formulate extended supply chain relationships; functional use of internet in design, manufacturing, marketing, selling, presenting and data-based management model” (Schallmo et al, 2018).

2. LITERATURE REVIEW

2.1. Lithuanian manufacturing sector

The industry is part of the economy producing material goods that are mechanized and automated (LASI et al. 2014). According Manufacturing risk index (2018) Lithuania is rated amongst the Top 5 global manufacturing destinations in the world. While Lithuanian manufacturing is currently enjoying a period of dynamic growth, the combination of rapid



increase in labour costs and lagging productivity, together with the dominance of low-tech sectors in the Lithuanian manufacturing structure, put significant pressure on the competitiveness of Lithuanian manufacturing sector.

Lithuania stands quite high in the size of the manufacturing sector, occupy leading positions (higher than the EU average 15%) and managed to sustain or increase the share of manufacturing in GDP (EUROSTAT, 2017). In regard to the structure of the manufacturing sector, Lithuanian manufacturing is heavily dominated (80% of total production) by the medium-low and low-tech sector (EUROSTAT, 2014), while in many other countries' economies, half of their manufacturing output is generated by the medium-high and high-tech sectors.

Lithuania had the lowest share of high-tech industry in manufacturing output in the whole EU, but has a higher rate of capacity utilization currently than in 2007; however, the Lithuanian rate of capacity utilization in manufacturing is much lower than in other countries (EUROSTAT, 2017).

Lithuania did not register substantial differences in trends in total employment and employment in the manufacturing sector. Growth in manufacturing output and labour working in this sector was noticed; however, it can be a sign of lagging investment into digitalization by Lithuania manufacturers; Country also lags behind in terms of wages in the manufacturing sector: hourly wages during 2017 in manufacturing sector were 3.5 times lower than the EU average (EUROSTAT, 2017).

Obviously that situation of the lowest share of high-tech industry in manufacturing output in the whole EU has to change and manufacturing sector has to improve this by investing in business structure improvements and reorienting to this type of enterprise creation (BICKAUSKE, 2020)

There are signs that businesses in Lithuania underinvest in digitalization processes. However, in order to remain competitive, companies will have to rethink their strategies concerning future investments.

2.2. Digitalization challenges for Enterprises

Experts highlight four areas for which digitization technologies will have the greatest impact: productivity, revenue growth, employment and investment (RUßMANn et al. 2015).



The increasingly affordable hardware and software solutions accelerate the transition towards the smart and interconnected factory envisioned by Industry 4.0 (ALMADA-LOBO, 2016).

Stoldt et al (2018) highlights that companies can implement two strategies to digitalize their business - transform their processes and production sites incrementally or implement radical change by exchanging entire processes and systems with fully digitalized ones. According to Stoldt (2018) SMEs typically do not have the economic strength to sustain such a revolution but are eager to employ novel technologies in their factories to raise their competitiveness.

Digital transformation can potentially create new possibilities for SME's (small and medium enterprises) and encourage new ways of development and growth). According to Sommer (2015), though, only big companies can benefit from Industry 4.0 while SME's can, adversely, become the victims of the standards of Industry 4.0. For the most of SME's it is hard to realise which digitalization technologies to choose and acquire and how to secure the financial incentives and means for the digital transformation of their operations. Raymond (2005) determined several operational indicators that, as SMEs may expect, can be significantly enhanced if companies invest into digitalization technologies: better quality, increased productivity, lesser costs of operation and greater flexibility.

When talking about the biggest challenges of digitalization, Peillon ir Dubrue (2019) offered a reasonable classification of potential digitalization obstacles for SMEs. This classification includes technological problems (related to financial and technical resources' limitations), organizational obstacles (related to the staff unwillingness for changes), obstacles related to human resources (such as constant lack of sufficiently qualified employees) and client-related obstacles (such as customer fear of losing their sensitive information and compromising security of their IT systems).

Moeuf (2018) mentions these production activity goals for SMEs: flexibility to adapt to the changes of a constantly changing market, cost reduction, increase in productivity, quality improvement and, shortening of delivery time. According to MOEUF (2018), flexibility is the most commonly determined goal of operational activities by the majority of market researchers and, which can be a surprising discovery for the practices since it is namely flexibility that is a common characteristic of SMEs allowing to distinguish themselves among other companies.



Bayo-Moriones (2013) offered a similar list of indicators after he had completed his study on application of new digital technologies to industrial enterprises which was, additionally, supplemented by a criterion of shortened-delivery-time.

All the above-mentioned operational activity indicators are important in order to assess Industry 4.0 impact on the flexibility, costs, productivity, quality and time frame of delivery of SMEs. Regardless of that, SMEs identify themselves as lagging behind the innovations of digitalization since the process of digital technology application remains slow-paced and companies bear the risk of being excluded from a digital delivery chain. Besides, SMEs tend to formulate faulty preconceived notions about the complexity and high price of digitalization (KILIMIS, 2019).

According to Rüttimann and Stöckli (2016), SMEs will be overburdened by the increased need for financial investments to the digitalization while Industry 4.0 installation and integration into the operational processes of large enterprise will considerably enhance their flexibility and it will help the latter to dominate the larger share of customized individual product market – a segment which is currently dominated by SMEs.

3. DATA AND METHODOLOGY

To assess the level of digitalization of Lithuanian manufacturing industry companies, the in-depth descriptive analysis on already-applied-digital-technologies in those companies was executed. The main goal of the analysis – to determine whether Lithuanian companies of processing industry has been sufficiently digitalized and are ready to fully adopt the principles of Industry 4.0 in the installation of digital solutions within all segments of the value-chain creation. The survey on the determination of digitalization level consisted of 50 questions grouped into 10 topics with each topic containing 5 questions. Ten topics of the survey were divided into separate groups by certain operational processes in the companies.

As a result, the answers to the survey questions provided data about the level of digitalization in the concrete processes of enterprise operational activities. Five question-blocks in each topic provides information whether a certain enterprises' operational activity is executed by the use of particular digital tool that is built-in in order to digitalize the control of that particular operational activity.

The topics of this questionnaire were designated to evaluate the level of digitalization in these operational activities of the companies: management of customer relations, management of product warrantee cycle, management of local network, quality assessment



(digitalized), execution and monitoring of production, planning of production and resources, digitalization of production, management of inbound logistics and warehouse, digitalized maintenance and servicing of equipment and management of laboratory or design information.

Question-blocks set main focus on whether the management of these processes is digitalized, if it uses certain IT systems and/or sensors, data harvesting and analysing databases and digitalized technical equipment which execute and control enterprises' production. With the help of these question-blocks there was an attempt to collect all the relevant data on the general level of digitalisation, the level of enterprise operational activities digitalization and particular digital tools (both already installed and in the process of being installed) in order to assess their relevancy and profitability to the Lithuanian manufacturing industry companies that participated in the questionnaire.

In the meantime, of analysis, there was a research on the already-installed digital tools and technologies in the questionnaire-companies being conducted. Analysis also enabled us to determine the mostly digitalized operational activities in these companies as well as to define the least digitalized or non-digitalized spheres of value-chain creation. After the determination of current level of digitalisation in the particular questionnaire company had been made the question of the strongest and weakest points of digitalization in the company was raised and answered as well as a search for the potential reasons for digitalization weaknesses was made. In the end a valuable particular dataset was collected concerning those particular enterprises and appropriate recommendations for particular enterprises were created. The key objective of those recommendations was to propose installation of additional tools and application of other means so as to activate existing digitalization processes in the companies.

3.1. Digitalization levels

Digitalization level in the questionnaire-companies was determined by using the table of Digitalization Levels provided by Digitalized Auditioning Methodology (see Table 1). The table describes four levels of enterprise digitalization which are used to determine the level of enterprises' operational process digitalization. The latter is assessed by the number of different already-installed digital tools into the value-chain creation of that particular enterprise beginning with marketing, product research, acquisition of resources, planning of processes, production, testing, logistics and finishing with sales, warrantee services and recycling.



Table 1: Levels of digitization of enterprises according to the amount of implemented technologies

Level of digitalization		Description of the nature of the level
1	Weak	The company has not implemented digital technologies or there is no need for their implementation
2	Middle range	The company has somewhat used various information communication technology tools to automate various processes
3	Good	The company uses the digitalization of various processes and is moving towards the development of Industry 4.0 in the areas necessary for the company
4	Excellent	The company is moving robustly towards Industry 4.0 technologies and several of the horizontal and vertical value chain processes have been digitized to the required level through various ICT solutions (both software and hardware)

Based on Digitalized Auditioning Methodology, there are three key inter-related enterprise development, productivity and competitiveness parts: the level of enterprise process digitalization, the level of flexibility, and the level of production line automation.

The optimal digitalization level is achieved when various digital technologies within a company completely run and control its whole chain of production: marketing, product research, purchase of resources, planning of processes, manufacturing, product testing, logistics, sales, warranty services and recycling.

The optimal level of flexibility is achieved when a high quality and affordable customized products are made which can be delivered to the customers within a shortened period of time. While the flexibility is divided into several types: the flexibility of production lines; flexibility of production; flexibility of quantities; flexibility of production delivery routes; flexibility of production processes; flexibility of product; flexibility of development. The latter notion of flexibility and its scope is very important when seeking a complete productivity and effectiveness in the company and it should involve as many stages in the production processes of the enterprise as possible.

The level of automation depends on how many automated tools are being used within production operations (CNC, robotics, resource management systems, etc.). Therefore, the efficiency of enterprises' operations, especially, when the enterprise is in its expansion phase, depends on the number and variability of digital tools installed and integrated into all the value-chain creation processes and, as such, encourages flexibility within all spheres of production from production lines to the product itself.

High level of digitalization makes a positive impact to the competitiveness and productivity of enterprises, however, during the digitalization of operational processes one bear in mind that companies must be prepared to adapt themselves the new normal of the relationship between a machine and a human. Industry 4.0 brings new paradigms of the smooth



human-machine interaction, that might be complicated to accept, especially in terms of current enterprises' preparedness with regard to the number of employees and their qualifications.

Even though those automated production machines interact with production planning systems autonomously, it is important to notice, that a human specialist integration into this renewed process requires for a new re-orientated vocational paradigm (Krupitzer, 2020). Therefore, the tasks of specialists will change according to the changing technologies in the enterprise, the number of needed specialists will change as well and there will be a new need for specialists with higher qualifications suitable for the management and control of newly digitalized innovative production processes in the enterprise.

3.2. The research data sample

For the data sample of this research 50 enterprises were chosen and the questionnaire was sent to them. 43 answers were received from those 50 entities.

The enterprises in the questionnaire represent these sectors:

- Food and beverages, tobacco producers (25% of all enterprises in the questionnaire);
- furniture manufacturers (5%);
- Toy, jewellery, musical instrument makers; machine and equipment installers and maintenance service providers (16%);
- Wood, paper and paper product producers; publishing and printing service providers (9%); electrical equipment producers (9%);
- Common metal and metal product producers (excluding motor and machine makers) (9%); scientific research and applied technology producers (5%);
- Construction companies (4%);
- Chemical product producers (2%);
- Rubber and plastic product producers (2%);
- Other machine producers (2%);
- Transport equipment producers (2%);
- Transport and warehousing service providers (2%);
- Informatics and connection services providers (2%);
- real estate operators (2%).



The largest share of these were represented by middle-sized enterprises (51%) with 50 to 249 employees. The lesser portion was represented by small (16%) and very small (12%), very big (12%) and big (12%) companies.

4. RESULTS AND DISCUSSIONS

The level of digitalization among the Lithuanian manufacturing industry enterprises is very different. Results within the research data sample varies from level 1, when 12% digitalization is reached within operations of the company to level 3, when 67% of all operational activities are digitalized. General level of industrial digitalization varies from 2 to 27,4% digitalized operational activities as mentioned earlier in this research among the Lithuanian manufacturing industry enterprises. This value indicator of digitalization level indicates that enterprises possess already installed informational-communicational technological tools and devices designated to automatize their production processes.

The main underlying reason, why the level of digitalization among the enterprises in the questionnaire does not reach the higher margin is that these enterprises receive many individual production orders and contracts. These individual production contracts and orders are of limited scope and quantities, thus, it is very complex and costly process to automatize the production with currently held technological tools and devices. Therefore, in the case of these individual order fulfilments, it is far more beneficiary to employ higher numbers of employees with lower qualifications rather than to automatize the production lines with the help of digitalization.

The companies in the questionnaire perceive the importance and benefits of automation and industrial digitalization and have plans of which processes they would digitalize. Part of them are ready for the changes, because they understand that digitalization will secure their competitiveness in the future market. However, the main challenges that stand in their way towards higher extent of digitalization are the resistance of their staff and the lack of change management skills among their managers. Another important reason is uncertainty if the digitalization of industrial processes will pay off over time.

It deters businesses from digitalization because they simply do not know whether their profits would sufficiently increase after investments into industrial digitalization. The last reason for digitalization avoidance among the companies in the questionnaire is the lack of knowledge about the most suitable digitalization tools and technologies for each particular enterprise. For these reasons, the analysis of already-installed digital tools was executed in



parallel with evaluation of activities indicators by comparing if these indicators were bigger in the companies with higher levels of digitalization than in those with zero levels digitalization.

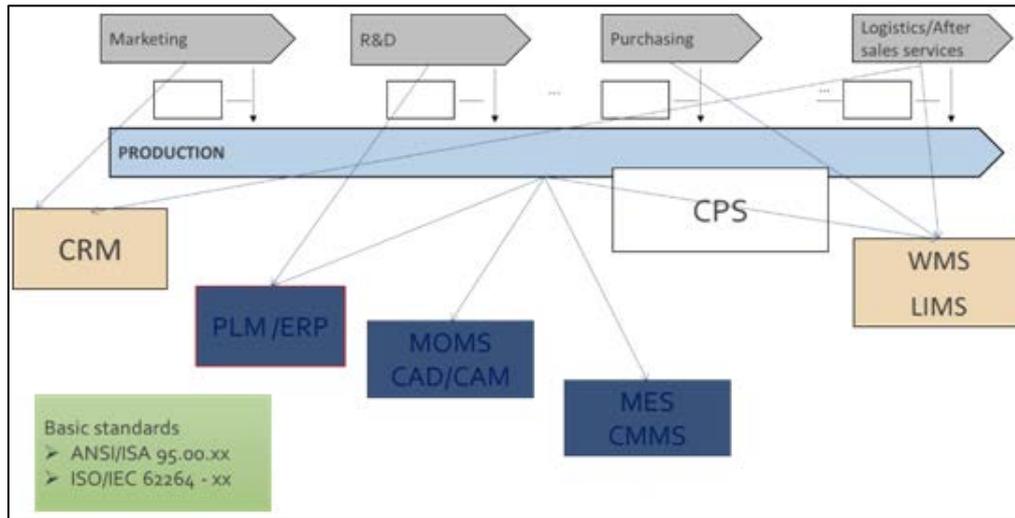


Figure 1: Digitalization value chain

In the table below (see Table 2) there are topics of questionnaire which were given in logical sequence according to the enterprise operational processes beginning with activities in value-chain creation (see Picture 1) such as the management of company, planning of orders, execution of orders; and closing with key operational activities such as the organizing of production and its management.

Table 2: Level of digitization of enterprises by business processes as a percentage

Digitalized processes	Min	Max	Average level	Std error	Median
1. Digitalization in a Customer Relationship Management (CRM)	0.0%	100.0%	36%	28.1%	35.0%
2. Digitalisation in technology planning, product lifecycle management (PLM)	0.0%	100.0%	45%	26.6%	45.0%
3. Vertical and horizontal value chain integration through Computer networks	0.0%	100.0%	46%	23.0%	50.0%
4. Digitalization in a Computer Aided Quality Control (CAQ)	0.0%	70.0%	15%	19.0%	10.0%
5. Digitalization in production monitoring, using manufacturing execution system (MES)	0.0%	90.0%	31%	22.8%	30.0%
6. Digitalization in production planning, enterprise resource planning (ERP)	0.0%	100.0%	26%	26.0%	20.0%
7. Using hardware for digitizing the manufacturing (towards Cyber Physical Systems – CPS)	0.0%	70.0%	17%	20.1%	10.0%
8. Digitizing the inbound logistics and warehouse management (WMS)	0.0%	70.0%	16%	19.7%	10.0%
9. Digitizing equipment maintenance process (CMMS)	0.0%	100.0%	20%	23.3%	15.0%
10. Digitizing quality assurance and laboratory information management (LIMS)	0.0%	100.0%	23%	25.7%	20.0%

During assessment of the level of enterprise digitalization by the topics of the questionnaire from the first to the tenth named process, there was derived a relatively consistent estimate of enterprise operational process digitalization. When analysing different spheres of production operations, the strong and the weak sides of enterprise level of digitalization within value-chain creation were determined.

The table above illustrates that the most digitized value chain processes in enterprises are as follows: Customer Relationship Management (36 proc.), Digitalisation in technology planning, product lifecycle management (45 proc.) and Vertical and horizontal value chain integration through Computer networks (46 proc.) (see Table 2). This shows that companies are focusing on embedding digital tools in key value creation processes that drive sales, help develop new products, manage orders efficiently, perform production efficiently, and help to increase company productivity and reduce costs.

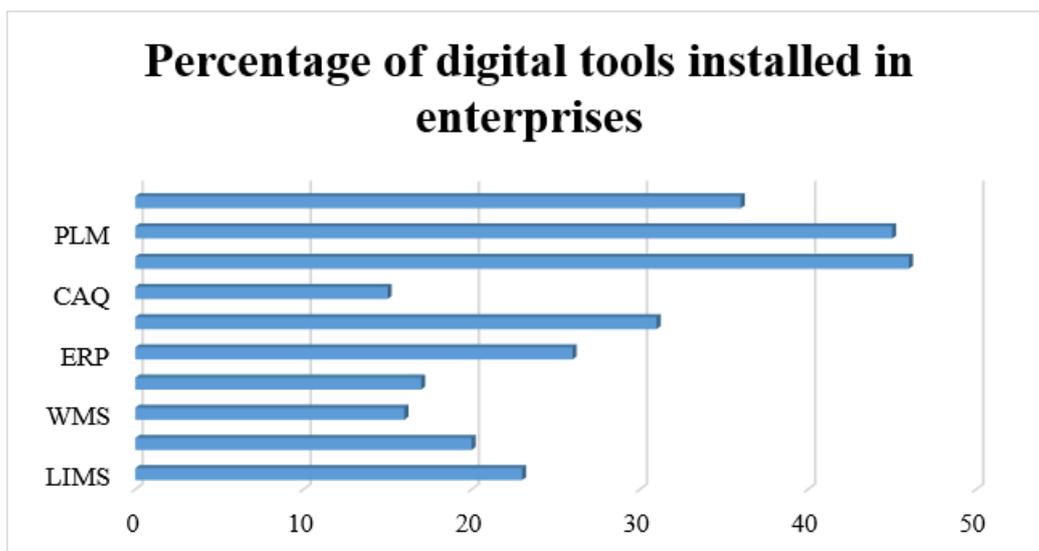


Figure 2: Percentage of digital tools installed in enterprises

As a result, it can be stated, that the most-commonly installed digital tools to the above-mentioned enterprise operational processes are as follows (see Picture 2): digitalization of customer relationship management (CRM), digitalization of product lifecycle management (PLM activity integration through computer networks (LAN, IoT, Internet), digitalization of manufacturing execution system (MES) and digitalization of enterprise resource management (ERP).

These digitalization tools are chosen because of their inter-synchronization features as well as synchronization with other enterprise IT systems and production tools. CRM helps to increase the sales and to enhance relationship with enterprise customers. Moreover, it helps to

define key target markets, the demand of particular products. PLM is useful in collecting the information basis from the creation to the mass production of the particular product, which is extremely important while creating new products according to the clearly expressed customer needs. Computer networks and data exchange systems (LAN/IoT) enables a digitalized managing of production orders, simultaneously managing related information through different departments and employees, that ensures integration of the operational processes.

Due to this integration the orders for production are delivered smoothly and efficiently. After that a manufacturing execution system (MES) is used which manages production operations and simultaneously collects information which enables the staff to execute an efficiency analysis in the production line. Enterprise resource management digitalization tool (ERP) enables the staff to more efficiently plan the orders for production and production operations, thus, reducing the costs of operations. All these above-mentioned digitalization tools support enterprises in their attempts to digitalize everyday business operations and ease the workflow for the employees in the company.

When comparing the questionnaire-enterprises in terms of whether they already have installed or have not installed these most-commonly applicable digitalization tools, the obvious differences in performance indicators come into sight. Companies with already-installed customer relationship management tool CRM are middle-sized entities, with annual turnover of 5-10 mln. EUR whereas 75-100% of annual turnover share is for export. Key production areas of activities are manufacturing of transport equipment and electrical appliances, metal products and food products. Companies which have not installed such tool are middle-sized, too, with annual turnovers of 10-20 mln. EUR whereas the 50-75 % of annual turnover share is for export.

Key production activity areas are food production, wood processing, and paper production. The main difference between these two groups of enterprises is the fact non-existent CRM tool means in average 29% more employees working in the company with no CRM compared to the company which has already applied CRM tool to its operations. That means, that CRM requires fewer employees to do the same job and, as such, saves the costs of enterprise operations. However, enterprises with no CRM produce products (food and wood, paper production) where orders are often individualized and require manual work and personal order management when working with the clients.



Therefore, after the analysis of digitalization levels in Lithuanian enterprises of manufacturing industry that took part in the questionnaire have been made, it was determined, that general level of digitalization among the questioned enterprises is average (the second from 4 possible). Enterprises have installed informational-communicative technology tools designated to automatize their operations.

The most digitalized processes within the creation of enterprises' value chain are the management of customer relationship, technological planning and product lifecycle management, integration of vertical-horizontal value-chain parts, monitoring of manufacturing, management and monitoring and execution of production, enterprise resource management. The latter factor indicates that companies tend to install digitalization tools into those processes which have the most considerable impact on product sales, new product creation, efficient management of orders, efficient execution of production and planning in a way that the overall enterprise efficiency increases and the costs decrease. As a result, the above-mentioned digitalization of determined processes has a tremendous impact to the enhancement of productivity, competitiveness and operational efficiency of enterprises.

The most popular digital tools to digitize the above-mentioned processes are:

- 1) Customer Relationship Management (CRM):
 - reduces the need for human resources to carry out the company's activities,
 - increase sales,
 - encourages to create innovation and new products,
 - ensures the development and competitiveness of enterprises;
- 2) Product Lifecycle Management, Process planning (PLM):
 - increases productivity,
 - increases export volumes,
 - facilitate working conditions for human resources,
 - ensures product quality;
- 3) Computer Networks and Data Exchange (IoT/M2M):
 - increases turnover;
- 4) Manufacturing Execution System, Production monitoring (MES):



- increases productivity,
- standardize work procedures and optimize performance,
- increases competitiveness,
- increases turnover and export volumes;

5) Enterprise Resource Planning (ERP):

- increases productivity,
- reduces costs.

To sum up, there are these most-commonly distinguished positive changes of performance indicators among the companies who have already applied one of the mentioned digitalization tools: fewer actual employees are needed; the productivity of existing staff increases significantly; the increase in production size and quantities. These positive changes increase the turnover of the companies and strengthen their competitive advantage in the market.

5. CONCLUSIONS AND RECOMMENDATIONS

During the conduction of analysis, it was found out that there were these major challenges deterring the Lithuanian manufacturing industry enterprises to take forward steps towards higher level of industrial digitalization:

- a) Employee resistance and the lack of knowledge how to manage the essential changes – newly installed digitalization tools often change the order of work, methods of work, security requirements; a need for employee re-qualification process arises;
- b) The lack of financial resources and slow return of investments – SMEs do not tend invest into industrial digitalization because the profits from the latter come over a long period of time and it is slow in general; smaller turnovers of SMEs also make an impact on their decisions whether to invest into the digitalisation.
- c) The lack of knowledge when choosing the solutions for digitalization –enterprises often have different technologies installed into separate fields of operations, however, they lack knowledge of how to unify all of them with an efficient digitisation tool which could synchronize different tools and manage all the operations centrally.



- d) Constant shortage of qualified specialists – companies tend to think often that every new digitisation tool they are going to install will additionally require skilful specialists who could work with them and, as a result, it will cost the company extra.
- e) Lack of specialists - companies often believe that the implementation of new digital tools will require the employment of new professionals who are able to work with these digital technologies, which will require additional costs from companies.

After assessing the problems and challenges expressed by the companies participating in the survey, the following recommended solutions for the application of additional measures and / or the implementation of tools for the activation of digitization processes are presented in the table 3:

Table 3. Recommended solutions for increasing the level of digitization of enterprises

Nr.	Measure	Description
1.	Employee awareness raising	1. To develop an understanding why digitization is relevant to the growth of the company. 2. To develop an understanding of change management and how to use it. 3. To expand the understanding of process management and improvement, concept of digitization and use case analysis.
2.	Attracting EU support	1. Take advantage of the opportunities provided by the EU support for the development of digitization in production companies.
3.	Experts consultation	1. To consult scientists on the selection of appropriate digital tools. 2. Carry out an audit of the level of digitization of companies.
4.	Specialized training	1. To organize trainings how to use IT tools such as CRM, CAD, LEAN, etc. 2. Use the opportunities provided by the EU support for staff training.

Source: Created by the authors

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