# ANALYSIS AND PERSPECTIVES OF THE LEVEL OF DIGITALIZATION OF ENTERPRISES IN THE EU MANUFACTURING SECTOR

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***Abstract.*** *The impact of technological advances is being felt in all industry sectors; thus, there is no doubt that digital transformation will significantly affect the Lithuanian manufacturing sector. In order to assess the extent to which companies in the Lithuanian processing industry are digitalized, an in-depth descriptive analysis of installed digital technologies in these companies was executed. The goal of this analysis was to determine whether Lithuanian companies in the processing industry have 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 value-chain creation. Research on the digital tools and technologies that have already been applied in these companies was performed during the phase of analysis. A comparative analysis of EU countries was also performed, during which countries were analyzed by criteria such as changes in production outputs and number of employees, changes in the share of manufacturing in GDP, share of high-tech sectors in total manufacturing output, level of capacity utilization, share of employees in the manufacturing sector in total employment, personnel costs, and wages. There was also an attempt to define the most digitalized processes of operation and the least (or non-) digitalized processes of operation in companies. After the assessment of the current digitalization level in the company, there was an attempt to clarify the strengths and problematic challenges as well as the underlying reasons for these 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 these companies were formulated and passed on to the companies.*

***Keywords:*** *digitalization, employment, manufacturing sector, competitiveness.*

## Introduction

The European Commission (2017) has 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 GDP of the EU back to 20% by 2020. The European Parliament states that 80% of all innovation and

exports come from industry, as do many jobs. For this reason, the main focus of EU policies must be strengthening Europe's industrial base. Despite numerous 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 (Roland Berger Strategy Consultants, 2015).

The OECD (2018) report shows that not only routine manual workers are at risk, but also the places of highly skilled workers whose work can be replaced by software. More productive workplaces with simple working algorithms featuring unambiguously definable procedures are more threatened, but also those jobs whose tasks can be replaced by software solutions (accounting, administration). On the other hand, there are jobs that do not require high qualifications, yet they are not easily artificially substituted (OECD, 2018).

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 as it can bring new opportunities for SMEs by improving the entire value chain (Kilimis et al., 2019). In the scientific literature, authors emphasize the importance of industry digitization (Wang et al., 2016; Qin et al., 2016). They state that companies need to implement the latest technology, and that digitalization will have a monumental impact on the global economy, so vast and multifaceted that it will make 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).

In order to generate specific steps/recommendations in regard to the digitization of Lithuanian industry, it is useful to study existing cases of industry digitization in other EU member states.

## Literature review

Industry is the part of the economy producing material goods that is mechanized and automated (Lasi et al., 2014). According to the Global Manufacturing Risk Index (Cushman & Wakefield, 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 increases in labor costs and lagging productivity, together with the dominance of low-tech sectors in the Lithuanian manufacturing structure, have put significant pressure on the competitiveness of the Lithuanian manufacturing sector. The majority of entrepreneurs recognize the concept of Industry 4.0 as a significant opportunity for development and improvement in competitiveness (Ślusarczyk, 2018). The strengthening of the digitalization processes in EU industry may put additional competitiveness pressures on Lithuanian manufacturing businesses. In order to maintain the competitiveness of Lithuanian industry, steps towards the digitalization of industry have to be implemented. Digitization offers the potential for quality improvement, flexibility and productivity (Hoellthaler et al., 2018).

Lithuania stands quite tall regarding the size of its manufacturing sector, which occupies a leading position (higher than the EU average of 15%), and has managed to sustain or increase the share of manufacturing in its 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 has the lowest share of high-tech industry in manufacturing output in the whole of the EU, but currently has a higher rate of capacity utilization 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 labor in this sector was observed; however, this can be a sign of lagging investment in digitalization by Lithuanian manufacturers. The country also lags behind in terms of wages in the manufacturing sector: hourly wages during 2017 in the manufacturing sector were 3.5 times lower than the EU average (Eurostat, 2017).

Obviously, the situation regarding Lithuania having the lowest share of high-tech industry in manufacturing output in the whole of the EU has to change, and the manufacturing sector has to improve this by investing in business structure improvements and reorienting towards the creation of this type of enterprise (Bičkauskė et al., 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.

Experts highlight four areas in which digitization technologies will have the greatest impact: productivity, revenue growth, employment and investment (Rußmann et al., 2015). Increasingly affordable hardware and software solutions accelerate the transition towards the smart and interconnected factories envisioned by Industry 4.0 (Almada-Lobo, 2016).

Stoldt et al. (2018) highlighted 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 et al. (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 SMEs (small and medium enterprises) and encourage new ways of development and growth. According to Sommer (2015), however, only large companies can benefit from Industry 4.0, while SMEs can, adversely, become victims of the standards of Industry 4.0. For most SMEs, it is hard to understand 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, reduced costs of operation and greater flexibility.

When talking about the biggest challenges of digitalization, Peillon and Dubrue (2019) offered a reasonable classification of potential digitalization obstacles for SMEs. This classification includes technological problems (related to financial and technical resource limitations), organizational obstacles (related to the unwillingness of staff to change), obstacles related to human resources (such as the constant lack of sufficiently qualified employees) and client-related obstacles (such as customers' fear of losing their sensitive information and compromising the security of their IT systems). Moeuf et al. (2018) mentioned the following 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 et al. (2018), flexibility is the most commonly determined goal of operational activities by the majority of market researchers, and can offer surprising benefits for their practices. This is because it is flexibility that is a common characteristic of SMEs, allowing them to distinguish themselves among other companies.

Bayo-Moriones et al. (2013) offered a similar list of indicators after their study on the 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 the impact of Industry 4.0 on the flexibility, costs, productivity, quality and delivery time frame of SMEs. Regardless, SMEs identify themselves as lagging behind the innovations of digitalization since the process of digital technology application remains slow, and companies bear the risk of being excluded from the digital delivery chain. Moreover, SMEs tend to formulate faulty preconceived notions about the complexity and high price of digitalization (Kilimis et al., 2019).

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

## Trends in manufacturing output

While Lithuania lags behind in terms of innovative output in manufacturing, the Lithuanian manufacturing sector stands out among other economies in terms of the rapid growth of production output. In the previous 5 years alone, Lithuanian manufacturing output rose by a third, mainly driven by increasing sales in export markets. Despite the fact that Lithuania has enjoyed very rapid growth in manufacturing output compared to other selected economies, the dominance of the low and medium-low tech sectors in manufacturing restricted the turnover per person employed in Lithuanian manufacturing. For example, in 2011–2015, the turnover per person in Lithuanian manufacturing stayed the same, while the actual production output grew rapidly. Therefore, in general, while Lithuanian manufacturing companies are producing more and more goods, typically they do not earn more revenue per person employed. Other economies managed to sustain a gradual increase in turnover per person employed.

Statistics on capacity utilization draw a particularly interesting picture when comparing Lithuania to other countries (see Figure 1). Lithuania currently has a higher rate of capacity utilization than in 2007 (before the global financial crisis). This is an optimistic sign, given that a rising rate of capacity utilization typically implies that manufacturing companies are planning to invest in additional capacity.

Manufacturing companies in many other countries are using production capacity to a much higher level than in Lithuania. Actually, in comparison to other EU economies, Lithuania is in the group of countries with the lowest rate of capacity utilization in the manufacturing sector – despite the fact that the Lithuanian manufacturing sector is enjoying very dynamic growth in production output.

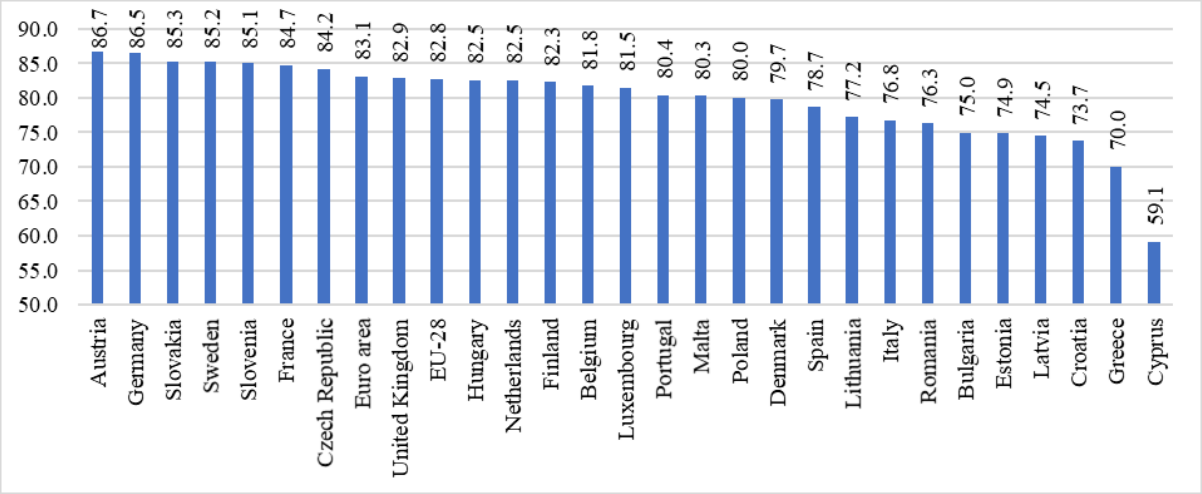



**Figure 1. Level of manufacturing capacity utilization in 2017, %**
*Source: Eurostat (2017)*

Human capital becomes more important, because not only does more have to be done with lower human resources, but organizations also need motivated employees (Bal et al., 2010). Human capital that is skillfully managed and integrated in workplaces has a positive effect on the organization's results (Foster, 2010). As regards employment in manufacturing, it is interesting to observe the long-term trend in the share of employment in manufacturing within total employment – and the trend in digitalization is clearly evident here (see Figure 2).

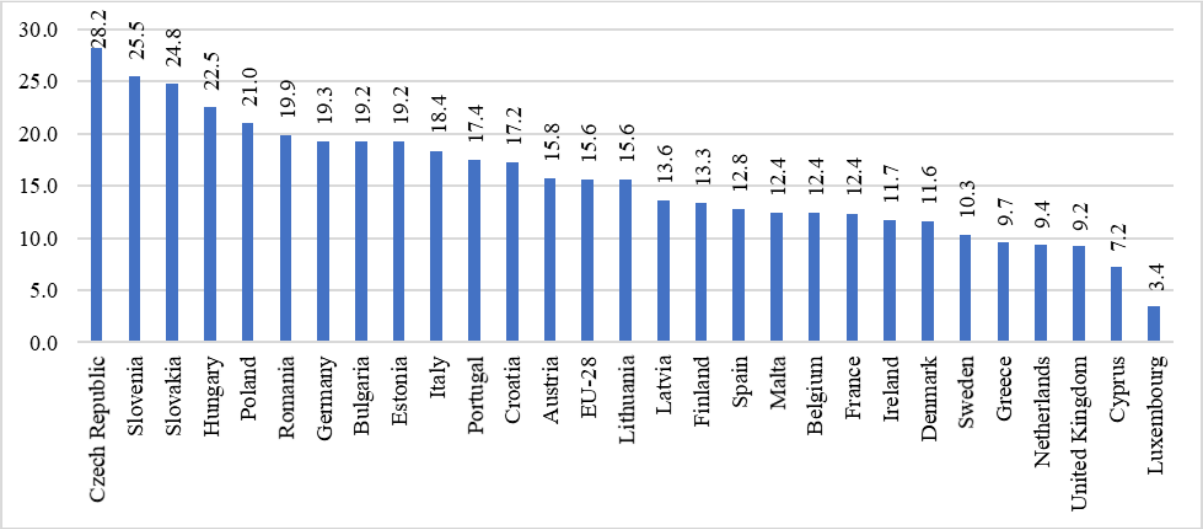



**Figure 2. Share of employees in the manufacturing sector in total employment in 2017, %**
*Source: Eurostat (2017)*

In regard to the share of employment in the manufacturing sector as a percentage of the total number of employees in the whole economy, the Czech Republic, Slovenia and Slovakia are the leaders among the economies in Europe. Almost one quarter of all employees are occupied in the manufacturing sector in these countries. As Kamal-Chaoui (2018) said, the question is whether advanced automation and digitalization will reduce the number of available jobs, or just transform the traditional professions into new digital professions.

Digitalization trends in the manufacturing sector are also clearly visible when comparing the change in the number of employees between 2010 and 2017 in the total economy and in the manufacturing sector. In some of the selected economies, a substantial difference in employment trends in industry and in the total economy can be observed. Lithuania did not register substantial differences in trends in total employment or employment in the manufacturing sector. In Lithuania, the total number of employees in 2017 rose by 6.6% compared to 2010, while the number of employees in the manufacturing sector rose by 7.2%. Of course, rapid growth in manufacturing output is a very important reason for this; however, it can also be a sign of low investment in digitalization by Lithuanian manufacturers.

Lithuania substantially lags behind the other countries in terms of wages in the manufacturing sector: hourly wages in the Lithuanian manufacturing sector in 2017 were 3.5 times lower than the EU average (Figure 3). A key factor behind such visible differences in salaries is the significant difference in the structure of manufacturing from the innovation point of view. Lithuanian manufacturing is still strongly dominated by low-tech (Figure 4) sectors and contract manufacturing businesses. In the report above, it was also shown that 85% of employees in the manufacturing sector are employed in the medium-low and low-tech sectors in Lithuania. Data from Eurostat also shows that Lithuania lags substantially behind other EU member states in employment in high-tech industry, as observed in the graph below.

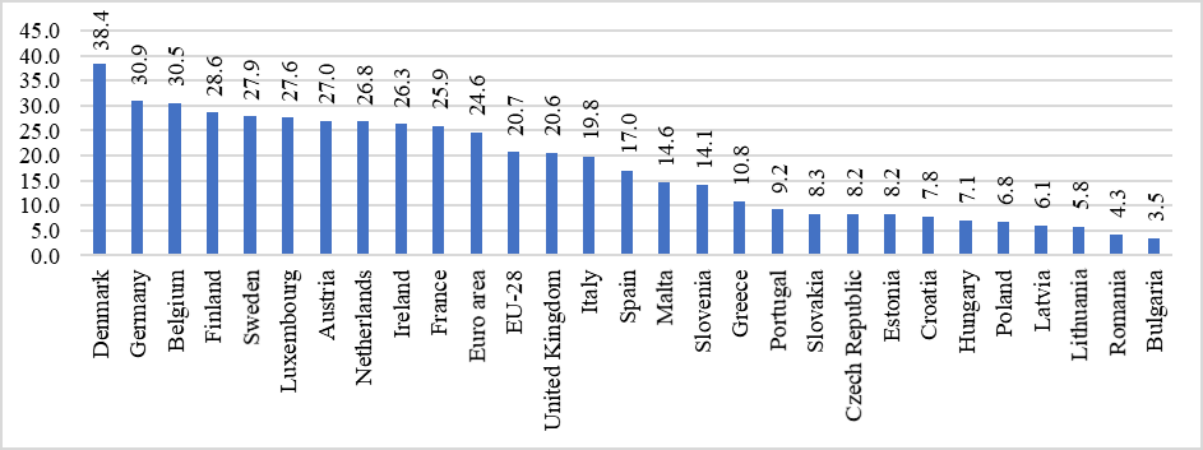



**Figure 3. Manufacturing salaries in 2017, €/hour**
*Source: Eurostat (2017)*

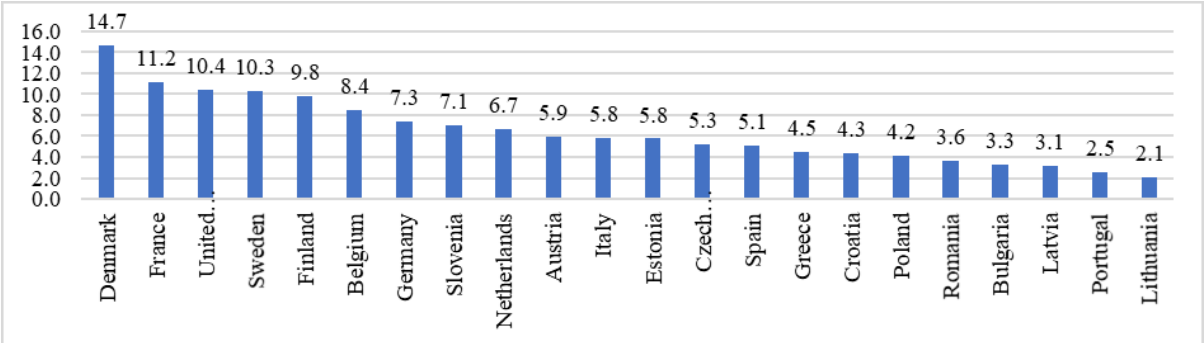



**Figure 4. Share of total manufacturing employment occupied by employees in the high-tech manufacturing sector in 2014, %**
*Source: Eurostat (2014)*

Data from Eurostat shows that labor costs account for 14.4% of the total expenditure of the Lithuanian manufacturing industry, but their share is rising rather rapidly: in 2011, for example, this figure stood at 9.5%. In 2010–2015, however, the wages and the share of personnel costs in total manufacturing expenditure in Lithuania both rose by 27% – perhaps a sign that Lithuanian manufacturing companies are underinvesting in digitalization.

## Data and methodology

To assess the level of digitalization of Lithuanian companies in the manufacturing industry, an in-depth descriptive analysis of the digital technologies already applied in those companies was conducted. The main goal of the analysis was to determine whether Lithuanian companies in the processing industry have 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 creation of the value-chain. The survey on the determination of the level of digitalization consisted of 50 questions grouped into 10 topics, with each topic containing 5 questions. The ten topics of the survey were divided into separate groups based on 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 enterprises' operational activities. Five blocks of questions in each topic provided information on whether the operational activity of a certain enterprise 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 designed to evaluate the level of digitalization in the following 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. The question block mainly focused on whether the management of these processes is digitalized, whether they use certain IT systems and/or sensors, data harvesting and analyzing databases, and digitalized technical equipment which execute and control the enterprises' production. With the help of these question blocks, there was an attempt to collect all the relevant data on the general level of digitalization, the level of digitalization of the enterprise's operational activities, and particular digital tools (both already installed and in the process of being installed). This was conducted in order to assess the relevancy and profitability of these tools to the Lithuanian manufacturing companies that participated in the questionnaire.

Concurrently, research on the digital tools and technologies already installed in the companies that responded to the questionnaire was being conducted. This analysis also enabled us to determine the most 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 the current level of digitalization in the particular company had been made, the question of the strongest and weakest points of digitalization in the company was raised and answered, and a search for the potential reasons for weaknesses in digitalization was conducted. In the end, a valuable and specific data set was collected concerning these enterprises, and appropriate recommendations were created for them. The key objective of these recommendations was to propose the installation of additional tools and the application of other means so as to activate existing digitalization processes in these companies.

## Digitalization levels

The digitalization level in the companies studied was determined by using the table of digitalization levels provided by the digitalized auditioning methodology (see Table 1). Table 1 describes the four levels of enterprise digitalization which are used to determine the level of enterprises' digitalization of their operational processes. This is assessed by the number of different digital tools already installed in the creation of the value chain in 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 implemented technologies**

| Level of digitalization | Description of the nature of the level |
|---|---|
| Weak | The company has not implemented digital technologies or there is no need for their implementation |
| Middle range | The company has somewhat used various information communication technology tools to automate various processes |
| 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 |
| 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 the digitalized auditioning methodology, there are three key interrelated parts to enterprise development, productivity and competitiveness: 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. This includes: marketing, product research, purchase of resources, planning of processes, manufacturing, product testing, logistics, sales, warrantee services, and recycling. The optimal level of flexibility is achieved when high-quality and affordable customized products are made, which can be delivered to customers within a short period of time. Flexibility is divided into several forms: flexibility of production lines; flexibility of production; flexibility of quantities; flexibility of production delivery routes; flexibility of production processes; flexibility of product; and flexibility of development. This notion of flexibility and its scope is very important when seeking complete productivity and effectiveness in a company, and it should be involved in as many stages as possible in the production processes of the enterprise. 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 the value-chain creation processes and, as such, encourages flexibility within all spheres of production – from production lines to the product itself.

A high level of digitalization has a positive impact on the competitiveness and productivity of enterprises. However, during the digitalization of operational processes, one must bear in mind that companies must be prepared to adapt themselves to the new normal of the relationship between a machine and a human. Industry 4.0 brings new paradigms of smooth human-machine interaction that might be complicated to accept, especially in terms of enterprises' current preparedness with regard to the number of employees and their qualifications. Even though automated production

machines interact with production planning systems autonomously, it is important to observe that the integration of a human specialist into this renewed process requires a new, re-orientated vocational paradigm (Krupitzer et al., 2020). Therefore, the tasks of specialists will change according to the changing technologies in the enterprise, the number of specialists needed will change, 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.

## The research data sample

A questionnaire was sent to 50 enterprises which were chosen as the data sample of this research, from which 43 answers were received. The enterprises in the questionnaire represent the following sectors: food and beverages, tobacco producers (25% of all enterprises in the questionnaire); furniture manufacturers (5%); toy, jewelry, and musical instrument makers; machine and equipment installers and maintenance service providers (16%); wood, paper and paper product producers or 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%); and 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%), very small (12%), very large (12%) and large (12%) companies.

## Results and discussion

The level of digitalization among enterprises in the Lithuanian manufacturing industry is very different. Results within the research data sample varied from level 1, where 12% digitalization is reached within the operations of the company, to level 3, where 67% of all operational activities are digitalized. The general level of industrial digitalization among Lithuanian enterprises in the manufacturing industry varies from 2 to 27.4%. These values of the indicator of the digitalization level indicate that these enterprises have already installed informational-communicational technological tools and devices designed to automatize their production processes.

The main underlying reason for 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 quantity; thus, it is a very complex and costly process to automate their production with current technological tools and devices. Therefore, in the case of fulfilling these individual orders, it is far more beneficiary to employ higher numbers of employees with lower qualifications rather than to automate 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 regarding which processes they would digitalize. Some are ready for these changes because they understand that digitalization will secure their competitiveness in the future market. However, the main challenges that stand in their way towards more extensive digitalization are the resistance of their staff and the lack of change management skills among their managers. Another important reason is uncertainty as to whether the digitalization of industrial processes will pay off over time. This deters businesses from

digitalization because they simply do not know whether their profits would sufficiently increase after investment into industrial digitalization. The final reason for avoiding digitalization among the companies that responded to the questionnaire was the lack of knowledge about the most suitable digitalization tools and technologies for each particular enterprise. For these reasons, an analysis of the digital tools already installed at these enterprises was executed in parallel with the evaluation of activity indicators. This consisted of comparing these indicators to assess whether they were larger in the companies with higher levels of digitalization than in those with zero levels of digitalization.

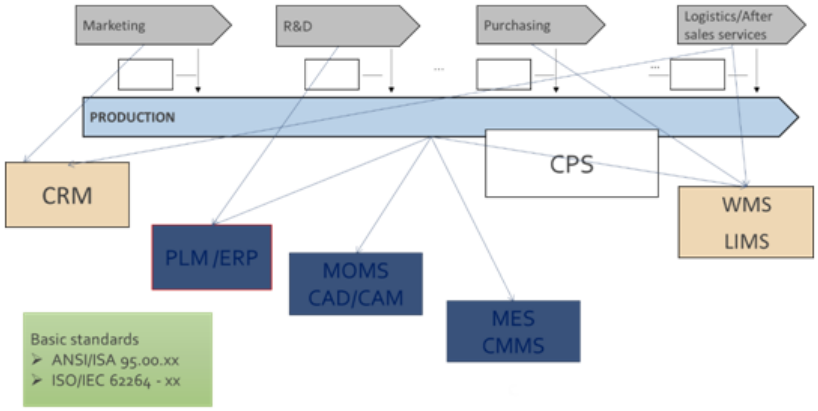



**Figure 5. Digitalization value chain**

In Table 2, the topics of the questionnaire are provided. These topics were given in logical sequence according to the operational processes of the enterprise, beginning with activities in value-chain creation (see Figure 5). This includes the management of the company, the planning and execution of orders, and key operational activities such as the organizing of production and its management. During the assessment of the level of an enterprise's digitalization based on the topics of the questionnaire, a relatively consistent estimate of the digitalization of the enterprise's operational process was derived. When analyzing different spheres of production operations, the strong and weak aspects of the enterprise's digitalization level within the creation of the value-chain were determined.

**Table 2. Level of digitization of enterprises by business processes**

| Digitalized processes | Min | Max | Average level | Std error | Median |
|---|---|---|---|---|---|
| 1. Digitalization in customer relationship management (CRM) | 0.0% | 100.0% | **36%** | 28.1% | 35.0% |
| 2. Digitalization 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 computer aided quality control (CAQ) | 0.0% | 70.0% | **15%** | 19.0% | 10.0% |
| 5. Digitalization in production monitoring, using a 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 manufacturing (towards cyber physical systems – CPS) | 0.0% | 70.0% | **17%** | 20.1% | 10.0% |
| 8. Digitizing inbound logistics and warehouse management (WMS) | 0.0% | 70.0% | **16%** | 19.7% | 10.0% |

| | | | | | |
|---|---|---|---|---|---|
| 9. Digitizing the 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% |

Table 2 illustrates that the most digitized value chain processes in enterprises are as follows: customer relationship management (36%); technology planning, product lifecycle management (45%); and vertical and horizontal value chain integration through computer networks (46%). 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.

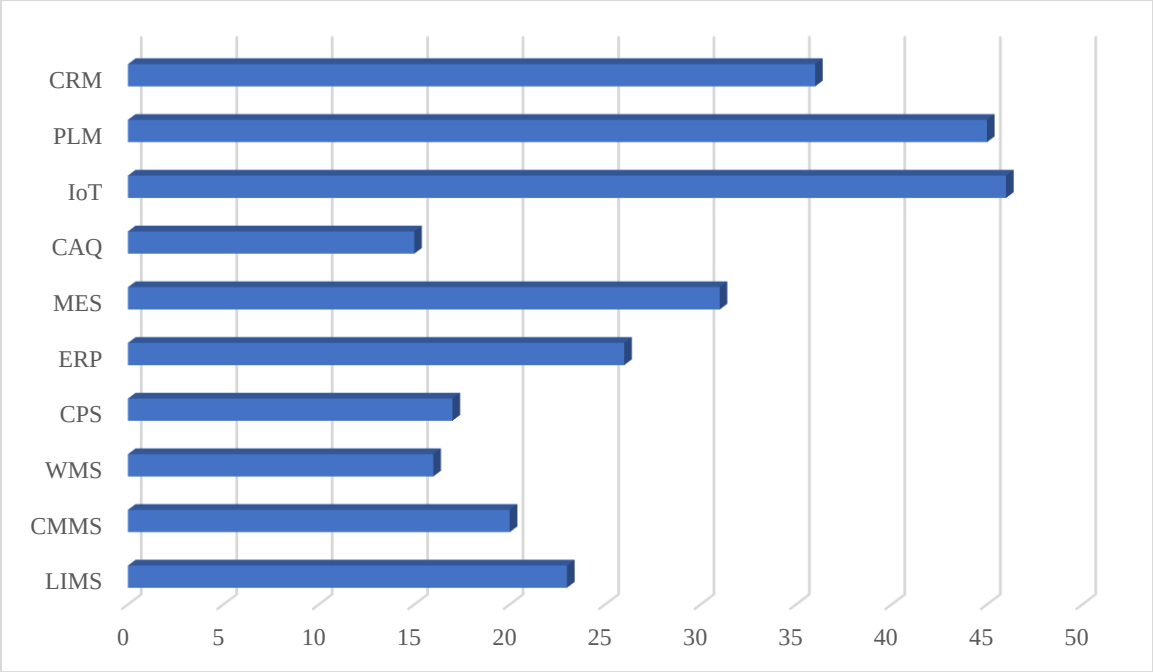



**Figure 6. Percentage of digital tools installed in enterprises**

As a result, it can stated that the most commonly installed digital tools in the abovementioned enterprises' operational processes are as follows (see Figure 6): 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 their synchronization with other enterprise IT systems and production tools. CRM helps to increase sales and to enhance relationships with an enterprise's customers. Moreover, it helps to define key target markets and the demand for 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 when creating new products according to clearly expressed customer needs. Computer networks and data exchange systems (LAN/IoT) enable the digitalized management of production orders, simultaneously managing related information through different departments and employees, thus ensuring the integration of operational processes. Due to this level of integration, orders for production are delivered smoothly and efficiently. Next, a manufacturing execution system (MES)

is used, which manages production operations and simultaneously collects information which enables staff to execute efficiency analysis in the production line. An enterprise resource management digitalization tool (ERP) enables staff to more efficiently plan orders for production and production operations, thus reducing the cost of operations. All of these above-mentioned digitalization tools support enterprises in their attempts to digitalize everyday business operations and ease the workflow of the employees in the company.

When comparing these enterprises in terms of whether they have or have not already installed these commonly applicable digitalization tools, obvious differences in performance indicators come into sight. Companies with pre-installed customer relationship management (CRM) tools are middle-sized entities, with annual turnovers of €5–€10 million and 75%–100% of their annual turnover coming from export. The key production areas of their activities are manufacturing transport equipment, electrical appliances, metal products, and food products. Companies which have not installed such tools are also middle-sized, with annual turnovers of €10–€20 million and 50%–75% of their annual turnover coming from export. Their key production activity areas are food production, wood processing, and paper production. The main difference between these two groups of enterprises is the fact that the non-existence of a CRM tool means, on average, 29% more employees working in the company. This means that CRM requires fewer employees to do the same job and, as such, saves the costs of the enterprise's 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 clients.

Therefore, after analyzing digitalization levels in the Lithuanian manufacturing enterprises that took part in the questionnaire, it was determined that general the level of digitalization among these enterprises is average (the second-lowest of the four possible categories). These enterprises have installed informational-communicative technology tools designated to automatize their operations. The most frequently digitalized processes within the creation of these enterprises' value chains are the management of customer relationships, technological planning and product lifecycle management, the integration of vertical-horizontal value-chain elements, the monitoring of manufacturing, the management, monitoring, and execution of production, and enterprise resource management. The latter factor indicates that companies tend to install digitalization tools in those processes which have the most considerable impact on product sales, new product creation, the efficient management of orders, the efficient execution of production, and planning, in such a way that the overall efficiency of the enterprise increases and costs decrease. As a result, the above-mentioned digitalization of the determined processes has a tremendous impact on the enhancement of the productivity, competitiveness and operational efficiency of enterprises.

The most popular tools to digitize the above-mentioned processes are listed below, along with their benefits.

*1) Customer Relationship Management (CRM):*

- reduces the need for human resources to carry out the company's activities;
- increases sales;
- encourages innovation and the creation of new products;
- ensures the development and competitiveness of enterprises.

*2) Product Lifecycle Management, Process planning (PLM):*

- increases productivity;
- increases export volumes;
- facilitates 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;
- standardizes work procedures and optimizes performance;
- increases competitiveness;
- increases turnover and export volumes.

*5) Enterprise Resource Planning (ERP):*

- increases productivity;
- reduces costs.

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

## Conclusions

Lithuania stands quite tall regarding the size of its manufacturing sector (see Figure 3), and occupies a leading position in this regard (higher than the EU average of 15%). Lithuania has also managed to sustain or increase the share of manufacturing in its GDP. In regard to the structure of the manufacturing sector, Lithuanian manufacturing is heavily dominated by the medium-low and low-tech sectors, 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 the high-tech industry in manufacturing output in the whole of the EU, but currently has a higher rate of capacity utilization than it did in 2007. However, the Lithuanian rate of capacity utilization in manufacturing is much lower than in other countries.

Lithuania has not registered substantial differences in trends in total employment and employment in the manufacturing sector. Growth in manufacturing output and labor in this sector was observed. However, this can be a sign of lagging investment in digitalization by Lithuanian manufacturers. The country also lags behind in terms of wages in the manufacturing sector: hourly wages during 2017 in the manufacturing sector were 3.5 times lower than the EU average. However, both wages and the share of personnel costs in total manufacturing expenditure rose by 27% in 2010–2015, which is a sign that Lithuanian manufacturing companies are underinvesting in digitalization.

Obviously, the situation where Lithuania has the lowest share of high-tech industry in manufacturing output in the whole of the EU has to change. The manufacturing sector has to improve this by investing in business structure improvements and reorienting towards this type of enterprise creation.

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.

During the analysis, it was observed that there are major challenges deterring enterprises in the Lithuanian manufacturing industry from taking steps towards a higher level of industrial digitalization.

1) Employee resistance and the lack of knowledge regarding how to manage essential changes. Newly installed digitalization tools often change the order of work, methods of work, and security requirements, creating the need for employee re-qualification processes.

2) The lack of financial resources and the slow return of investments. SMEs do not tend to invest into industrial digitalization because the profits from this come over a long period of time, and it is slow in general. Smaller SME turnovers also make an impact on their decisions as to whether to invest in digitalization.
3) The lack of knowledge when choosing solutions for digitalization. Enterprises often have different technologies installed in separate fields of operations; however, they lack knowledge of how to unify all of them with an efficient digitization tool which could synchronize different tools and manage all operations centrally.
4) The constant shortage of qualified specialists. Companies tend to think that every new digitization tool that they install will additionally require skillful specialists who can work with it and, as a result, it will cost the company extra.
After assessing the problems and challenges expressed by the companies participating in the survey, recommended solutions for the application of additional measures and/or the implementation of tools for the activation of digitization processes are presented in Table 3.

**Table 3. Recommended solutions for increasing the level of digitization of enterprises.**
*Source: created by the authors*

| Measure | Description |
|---|---|
| Raising employee awareness | 1. Develop an understanding of why digitization is relevant to the growth of the company.<br>2. Develop an understanding of change management and how to use it.<br>3. Expand the understanding of process management and improvement and the concept of digitization using case analysis. |
| Attracting EU support | 1. Take advantage of the opportunities provided by EU support for the development of digitization in production companies. |
| Consulting experts | 1. Consult scientists on the selection of appropriate digital tools.<br>2. Carry out an audit of the level of digitization of the company. |
| Providing specialized training | 1. Organize training on how to use IT tools such as CRM, CAD, LEAN, etc.<br>2. Use the opportunities provided by EU support for staff training. |

## References

1. Almada-Lobo, F. (2016). The Industry 4.0 Revolution and the future of manufacturing execution systems (MES). *Journal of Innovation Management*, *3*(4), 16–21.
2. Bal, P. M., Jansen, P. G. W., van der Velde, E. G., de Lange, A. H., & Rousseau, D. M. (2010). The role of future time perspective in psychological contracts. A study among older workers. *Journal of Vocational Behavior*, *76*, 474–486.
3. Bayo-Moriones, A., Billón, M., & Lera-López, F. (2013). Perceived performance effects of ICT in manufacturing SMEs. *Industrial Management & Data Systems*, *113*(1), 117–135. https://doi.org/10.1108/02635571311289700
4. Bičkauskė, D., Simanavičienė, Ž., & Jakubavičius, A. (2020). Trend analysis of industry digitization in EU manufacturing sector. In *The impact of Industry 4.0 on job creation 2019: Proceedings of scientific papers from the international scientific conference, 21 November 2019 Hotel Krym, Trenčianske Teplice Slovak Republic* (pp. 53–62). Trenčín: Publishing House Alexander Dubček University in Trenčín.
5. European Commission. (2017). *Communication from the commission to the European Parliament, the European council, the council, the European economic and social committee, the committee of the regions and the European investment bank, 2017. Brussels, 13.9.2017, COM (2017) 479 final*.

6. Eurostat. (2014). *High-tech statistics – economic data* [Archived content]. Retrieved September 22, 2019. https://ec.europa.eu/eurostat/statistics-explained/index.php/Archive:High-tech_statistics_-_economic_data
7. Eurostat. (2017). *Glossary: High-tech classification of manufacturing industries*. Retrieved http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:High-tech_classification_of_manufacturing_industries
8. Foster, R. (2010). Resistance, justice and commitment to change. *Human Resource Development Quarterly*, *21*(1), 3–39.
9. Hoellthaler, G., Braunreuther, S., & Reinhart, G. (2018). Digital Lean production and approach to identify potentials for the migration to a digitalized production system in SMEs from a Lean perspective. *Procedia CIRP*, *67*, 522–527. https://doi.org/10.1016/J.PROCIR.2017.12.255
10. Kamal-Chaoui, L. (2018). Preface. In OECD, *Job Creation and Local Economic Development 2018: Preparing for the Future of Work* (p. 3). Paris: OECD Publishing. https://doi.org/10.1787/9789264305342-en
11. Kilimis, P., Zou, W., Lehmann, M., & Berger, U. (2019). A survey on digitalization for SMEs in Brandenburg, Germany. *IFAC-PapersOnLine*, *52*(13), 2140–2145. https://doi.org/10.1016/j.ifacol.2019.11.522
12. Krupitzer, C., Müller, S., & Lesch, V., Züfle, M., Edinger, J., Lemken, A., Schäfer, D., Kounev, S., & Becker, C. (2020). *A survey on human machine interaction in Industry 4.0*. https://doi.org/10.48550/arXiv.2002.01025
13. Lasi, H., Kemper, H.-G., Feld, D.-I. T., & Hoffmann, D.-H. M. (2014). Industry 4.0. *Business & Information Systems Engineering*, *6*, 239–242. https://doi.org/10.1007/s12599-014-0334-4
14. Cushman & Wakefield. (2018). *Global manufacturing risk index 2018*. https://inventure.com.ua/upload/library/Manufacturing_Index_2018.pdf
15. Moeuf, A., Pellerin, R., Lamouri, S., Tamayo-Giraldo, S., & Barbaray, R. (2018). The industrial management of SMEs in the era of Industry 4.0. *International Journal of Production Research*, *56*(3), 1118–1136. https://doi.org/10.1080/00207543.2017.1372647
16. OECD. (2018). *Job creation and local economic development 2018: Preparing for the future of work*. Paris: OECD Publishing. DOI: https://doi.org/10.1787/9789264305342-en
17. Peillon, S., & Dubruc, N. (2019). Barriers to digital servitization in French manufacturing SMEs. *Procedia CIRP*, *83*, 146–150.
18. Qin, J., Liu, Y., & Grosvenor, R. (2016). A categorical framework of manufacturing for Industry 4.0 and beyond. *Procedia CIRP*, *52*, 173–178. https://doi.org/10.1016/j.procir.2016.08.005
19. Raymond, L. (2005). Operations management and advanced manufacturing technologies in SMEs. *Journal of Manufacturing Technology Management*, *16*(8), 936–955. https://doi.org/10.1108/17410380510627898
20. Roland Berger Strategy Consultants. (2015). *The digital transformation of industry*. Federation of German Industries (BDI). https://www.rolandberger.com/publications/publication_pdf/roland_berger_digital_transformation_of_industry_20150315.pdf
21. Rußmann, M., Lorenz, M., Gerbert, P., Waldner, M., Engel, P., Harnisch, M., & Justus, J. (2015). *Industry 4.0. The future of productivity and growth in manufacturing industries*. BCG. https://www.bcg.com/publications/2015/engineered_products_project_business_industry_4_future_productivity_growth_manufacturing_industries
22. Rüttimann, B. G., & Stöckli, M. T. (2016). Lean and Industry 4.0 – twins, partners, or contenders? A due clarification regarding the supposed clash of two production systems. *Journal of Service Science and Management*, *9*(6), 485–500.

23. Schallmo, D., Williams, C., & Boardman, L. (2018). Digital transformation of business models – best practice, enablers, and roadmap. *International Journal of Innovation Management*, *21*(8), 1740014. http://dx.doi.org/10.1142/S136391961740014X
24. Schwab, K. (2016). *The Fourth Industrial Revolution: What it means, how to respond*. World Economic Forum. https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/
25. Ślusarczyk, B. (2018). Industry 4.0 – Are we ready? *Polish Journal of Management Studies*, *17*(10), 232–248.
26. Sommer, L. (2015). Industrial Revolution – Industry 4.0: Are German manufacturing SMEs the first victims of this revolution? *Journal of Industrial Engineering and Management*, *8*(5), 1512–1532.
27. Stoldt, J., Trapp, T. U., Toussaint, S., Süße, M., Schlegel, A., & Putz, M. (2018). Planning for digitalisation in SMEs using tools of the digital factory. *Procedia CIRP*, *72*, 179–184.
28. Wang, S., Wan, J., Zhang, D., Li, D., & Zhang, C. (2016). Towards smart factory for Industry 4.0: A self-organized multi-agent system with big data based feedback and coordination. *Computer Networks*, *101*, 158–168. https://doi.org/10.1016/j.comnet.2015.12.017