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DECLARATION OF ACADEMIC INTEGRITY

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SUMMARY

Times are changing as well and the global business model in the manufacturing entertainments and others. 4.0 industry revolution becoming more necessary and popular among business units. Even the competitiveness is getting a different meaning - cooperation. The organization is searching for new, easier and cheaper ways to optimize their processes to achieve better quality standards and be competitive in the market. Robotization, optimization and technical movement are new industry trends, which started a few decades ago but becoming more visual now.

The purpose of this master thesis work is to analyze the research model and provide research samplings as a result. In the first chapter was analyzed the research problem or industrial possibility called 4.0 industry revolution, which is bringing together the wind of changes. Changes are visual in a business model, industries and manufacturing companies. 4.0 is a part of the research question because behind it it is new technologies as ERP, RFID, MES, EDI digital documentation and machines as wireless devices. The second part – theoretical with literature review, analyzing authors researches about the newest technologies and manufacturing systems influence to the production quality. Third – about the data analysis and SPSS program. In the fourth part, it was analyzed how the different digital systems can influence the manufacturing process and what is the main positive and negative feedback from the researches.

The main object in the thesis is how various systems; tools can affect activities performance in manufacturing organizations as production quality, delivery, flexibility, costs structure, and innovation.

The main research problem – which technologies, systems can positively influence manufacturing performance.

The main research question - how do depend variables affect independent variables and how to create the best quality in a process? According to the main research question about the manufacturing industries and the goal of the quality results, was created a conceptual research model (2 pics.).

The results part: method - questionnaire, information was gathered by telephone survey. Was used a quantitative research method. In total gathered 205 answers from 21 types of manufacturing industries.

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SANTRAUKA

Laikai keičiasi, taip pat ir tarptautinis verslo modelis gamybos ir kitose srityse. 4.0 Industrinė revoliucija tampa vis svarbesnė ir būtinesnė tarp verslo įmonių. Netgi konkurencingumas kaip sąvoka įgauna kitą apibūdinimą – bendradarbiavimas. Organizacijos ieško naujesnių, lengvesnių ir pigesnių būdų, kaip būtų galima patobulinti gamybos procesus ir pasiekti geresnių gamybos standartų, kurie suteiktų konkurencinį pranašumą. Robotizatimas, optimizavimas ir skaitmeninis technologijų pritaikymas yra nauja industrijos tendencija, kuri prasidėjo keliais dešimtmečiais anksčiau, tačiau tampa vis ryškesnė šiais laikais.

Pagrindinis tikslas šio magistrinio darbo - išanalizuoti tyrimo modelį pagal gautus pavyzdžius ir rezultatus. Pirmoje dalyje analizavau tyrimo problemą dar kitaip vadinama Industrine revoliucija, kuri atveša permainų vėją. Pokyčiai yra matomi verslo modelyje, industrinėse ir gamybos kompanijose. 4.0 taip pat yra analizuojamas tyrimo klausimas, nes po šia sąvoka slypi technologijos, kaip ERP, RFID, EDI, skaitmeninė dokumentacija ir skaitmeniniai prietaisai, mašinos. Antroje dalyje – teorinis tyrimas su autorių analize, kuriose apžvelgiama naujausių technologijų įtaka veiklos pasiekimams. Trečioje – aptariama gautų rezultatų analizė su naudota SPSS programa. Ketvirtoje dalyje analizavau, kaip skirtingos skaitmeninės sistemos gali turėti įtakos gamybos procesui ir kokią įtaką tai sukuria, teigiamą arba neigiamą.

Pagrindinis objektas šiame tyrime yra sistemos, prietaisai ir kaip tai veikia veiklos pasiekimus gamybos organizavime, kaip kokybėje, pristatyme, lankstume, kainų struktūroje ir inovacijose.

Pagrindinė tyrimo problema – kurios technologijos, sistemos gali turėti teigiamą įtaką gamybos veikloje.

Pagrindinis tyrimo klausimas – kaip priklausomi kintamieji veikia nepriklausomus kintamuosius, ir kaip tai įtakoja kokybės proceso kūrimą? Remiantis tyrimo klausimu apie gamybos industrijas ir pagrindinius siekius, buvo sukurtas tyrimo modelis, kuris pavaizduotas (2 paveikslėlyje)

Rezultatai: Pasirinktas metodas – klausimynas, informacija buvo surinkta telefonine apklausa. Pasirinktas kiekybinis informacijos metodas. Iš viso surinkta 205 atsakymai iš 21 skirtingų gamybos industrijų.

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INTRODUCTION

Relevance of the topic. In every single organization the main goal is to adapt to the market needs and reach the most optimal results with the smallest cost. The newest technologies are changing and the great example would be 4.0 revolution. Seek of advanced manufacturing system goal is to receive real-time demand of resources, workforce data and machine tools condition and information **(**Qu, Wang, Govil, Leckie, 2016)**.** 4.0 industry implementation changes in digitalization and robotization privides the organizations with decreased production time and improved quantity and quality standards. These essential changes in robotization are proceeding all around the world to create better service sector, product quality for the customers. It also brings better opportunities in the market according to demand by increasing or decreasing productivity in supply chain. But the main question is how manufacturing companies are accepting technologies, which are more useful and how all implementing process affecting manufacturing performance.

In this master work the main analyzing topic is relevant all around the world and in this research, it will be evaluated by how manufacturing companies interplay between independence variables and addicted variables and how it effects Lithuanian manufacturing companys achievements comparing it with competitive performance. Does the innovation is necessary in manufacturing process and it can influence positive results comparing with the other competitors and what is the most important in production quality creation.

Research problem. How digital manufacturing technologies relate with competitive performance dimensions such as such as quality, delivery, flexibility, cost, and innovations?

Purpose of the theses. To determine the relationships between digital manufacturing technologies and competitive performance such as quality, delivery, flexibility, cost, and innovations.

The research object. The association of digital manufacturing technologies and competitive performance dimensions such as quality, delivery, flexibility, cost, and innovations.

The research objectives:

1. To review scientific literature and systematize the relationships of digital manufacturing technologies with competitive performance.

2. To ground how digital manufacturing technologies relate with competitive performance.

3. To ground methodology which allows determining the relationships of digital manufacturing technologies and competitive performance.

4. To carry out empirical research and reveal the relationships between digital manufacturing technologies and compatitive performance.

Methods. Literature analysis and survey constitute the main methods of the study. Literature analysis was used to ground the relationships of digital manufacturing technologies with competitive performance, such as quality, delivery, flexibility, cost, and innovations. The survey was used collect data on the association of digital manufacturing technologies with the competitive performance of organziaitons. This study is based on the data of European nanufacturing survey in 2018. The sample constitutes 200 Lithunian manufacturing companies which have more than 20 employees. The descriptive statistics, bivariate correlation and multiple linear regression were used to analyse the collected data.

Structure of the thesis. The thesis is structured in the following way. The description of the present context of manufacturing companies constitutes the first part of the thesis. The digital nanufacturing technologies and performance dimensions are defined in the second part of the thesis. The association between the digital nanufacturing technologies and performance dimensions is also grounded in the second part. Further, the methodology of empirical research is detailed. Finally, the results are presented and implications of the study are discussed.

1. THE CONCEPT OF DIGITAL MANUFACTURING METHODS AND ACHIEVEMENTS

1.1 The concept of digital manufacture

4.0 industry revolution gives the opportunity and at the same time demands to make changes in the business sectors. In this chapter, the main task is to name and analyze the different aspects of digital manufacturing and what influence it has to the companies. From the previous researches different authors pointed out positive and negative technologies outcomes, but it all depends on the company size, type, functional capabilities. In this research first I will start from problem analyzes about what is manufacturing as a process and 4.0 industry revolution influence to the organizational achievements and competitive performance.

Production usually described as the processing of raw materials or others then recycled and after suitable for interest and sale. But the concept according to the new business model is changing. For example, Powell (2013) in his research describes the manufacturer as the middle is torn element between two opposing sides. In the 21th century, it is not enough just to produce production, now it is more important to analyze what is the real demand from the market and the customers and to find the best way to produce it on time. The main accomplishment in combination between manufacturing and digitalization – an integrated approach of computer systems and tools, which allows us to analyze, simulate and modeling all processes.

The first step is to understand the situation and position where is the manufacturing process existing. The second element would be to set a place of production in the manufacturing process and to know its own critical aspect: how to receive real-time demand, resource, and workforce data, machinery capacity, and condition information, to optimize manufacturing processes (Shuhui and et al., 2016). In other words, what kind of tools a company needs to reach better results in information flow, manufacturing process combined with the logistics chain. Looking from another angle, Navickas, Kuznetsova, Gruzauskas (2017) in their research mentions that the industry role is related to the missing link of human importance in technologically based approaches. How human can interact with the machines and digitalization, this is one of the research question combined with the existing manufacturing problem. Does the automatization will create faster and easier manufacturing chain and it will help to expand the business? Different tools can make changes to the system and for example, the technical driver approach as CPS (cyber-physical system), which is a mechanism controlled by a computer-based on algorithms, can play an important role in the industry.

As authors analyzed the main manufacturing functional abilities and what integrations could be made to improve the entire processes. From the researches it is visible that the manufacturing process is not the only production, it is also planning, controlling and include marketing with real-time data information. The main seek of the company to improve capacity and information flow between machines and management site. The results of implemented digital technologies would be improving customer satisfaction, reduce a time for manufacturing positive and resources. From the practical side the main problem - how to incorporate machines, new technologies and changes in the manufacturing activities to create a positive impact.

Manufacture organization has many different integration fields such as supply chain and operations management. As Sharif and Irani (2012) analyzing, management has routinely focused to reach bigger goals for effective strategies developed in order to design a slightly different model of production, delivery, support, and service. The result would be the positive changes in tools implementation in a real manufacturing model. But it is not enough just to have steps, all processes should be planned. The new really important role by Chan (2005) there it is existing demand and prediction of the forecasts, which can be the growth or recession, which is giving to enterprise the idea of the specific plan to create actions in the specific time period. One of the tools to predict such changes in the sales plan based on the company's operation planning. The main difference between a master plan and a sales plan is that the master is more detailed. The best example would be to calculate the time. It can be counted in the 1-month period and if it is in large - production scale - 1 week. To see the master planning in a wider spectrum of the horizon it can be set within 3÷12 periods depending on product position. For the company, it is to count different product planning plans, which can help to increase profitability or reduce material produce sells time.

According to the authors, planning and control should be in business production, because it is separated from all manufacturing functions. The main problem is how to predict the demand of the customer's needs and incorporation in real-time manufacture process. At the same time, the main question is should the companies implement new changes as master planning with digitalization tools and how it will influence the business. The full example of digital manufacturing is in (1 figure):

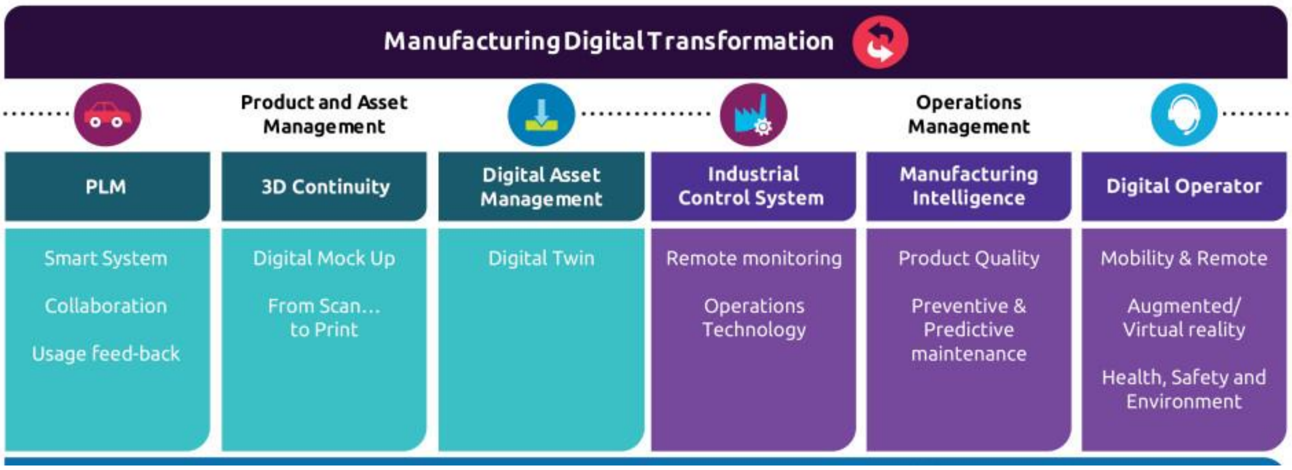

Figure 1. Complex systems simulation, Capgemini.com

In this (1 figure.) called Enterprise-wide manufacturing digital transformation. In the first column - Product and asset management – ensure collaboration between smart systems and receiving feedback. 3D technologies, align data and processes with delivering effective digital products and assets for management configuration. The really important factor is operational management – it can optimize industrial control systems by using manufacturing intelligence tools and capabilities. These processes are to ensure reduced time and optimized quality for the market. The really important aspect is security.

The main issue which was discovered in this chapter is the real-time demand and action on how to manufacture an organization can operate. According to Chan (2005), planning is the main and the most complex organization process, which includes the production activities which requires diverse information implementation. Greeff (2004) in his research mentioned planning together with digital tools. For example, to make e-manufacturing and supply chain effective we need to integrate various systems that can be accomplished with each other. Flexible manufacturing executive systems (MES) and supply chain (SCM) require competitive, latest plan automation. After need to be considered 4 critical aspects: how business affects physical processes, does the system support included processes, what is the value created to the company personnel and the last, what is the result of performance measurement?

In this chapter it was analyzed what is digital manufacturing importance of the planning, predicting customers' needs. It can be described as an integration process of different elements such as documentation, technical element – machines, management side, outside source – demand and production planning. Together with the process side by side go control and integration. The main issue what are the companies facing, how to predict the possible demand, prepare for it and maintain inside processes, how to create a system, to receive real-time information and take actions to save time. First, the company should understand and know the real need and then find and implement changes or tools. Implementing changes is such an issue because companies are not sure how it will affect the systems and what components are necessary, for objectives faced with specific areas and the interaction with the other systems, and the final positive result (Greeff, 2004). That's why in the next chapter the 4.0 industry revolution will be analyzed what effect and changes can be expected.

1.2 Industry revolution 4.0

When the environment is changing, many organizations are at the risk, because of the far too fast movement and the lack of adaptation. Many organizations could be left at the same point where they are now, and other companies will compete for real customer attention. Everything changes because of the different customer demands, marketing perspective and new appeared technologies. Every change and new implementations in the business process should start somewhere and with a reason. Changes of the society and in manufacturing side need to start step by step.

Dusko (2015) in his research analyzed how the past influenced 4.0 industry creations. The first industrial revolution emerged in the water and steam power mechanization. The second was mass manufacturing with the implementation of electric energy and the creation of the production lines. The third industrial revolution was a connection between the tools, products and the customer. Looking from the other side, that the customer is important and regarding those needs, should be made exceptional. The concept of Industry 4.0 has been developed in Germany since 2011, which amplified the necessary criteria to achieve and maintain the company's competitiveness. These criteria involved mass customization, high quality, and low production costs. Even more advanced concepts of cyber-physical systems (CPS) today considered as the main factor contributing to the development of Industry 4.0 (Navickas and et al., 2017). But other authors Dusko (2015) in his research, states that people sometimes have the wrong opinion about the industrial revolution. He is expressing that Industry 4.0 cannot be understood as a form of computer integrated manufacturing (CIM) because this approach was prematurely idea in the time as the idea was born. To find out the differences between author expressions about 4.0 we can see in 1 table.

Table 1. 4.0 revolution comparance between the authors Graffiths (2018), Vijaykumar (2015) and Dusko (2015) (made by author)

	Authors:	Changes:	Refection:	Results:
1	**Griffiths, Francis , Ooi, Melanie (2018)**	Disruptive technology which will touch everyone in the world	Long term solution	Reducing environmental pollution, better healthcare, energy and food resources
2	**Vijaykumar, Saravanakumar, Balamurugan,. (2015)**	Changing business environment	Development of Internet of Things, Big Data concepts	Influenced the new business models.Advanced production
3	**(Dusko L.(2015)**	Decentralized control and self-optimized systems)	Local optimization, consider uncertainties, allow error tolerance	Integrates the experience and the knowledge into the planning

As we can see from the (1 table) there are few similarities among the author's opinions, for example, all authors agree that it will be international changes and it will touch everybody, by creating different control systems. As Graffiths (2015) mentioning that 4.0 might be used as long term solutions for reducing environmental pollution because it is an important issue in our society. These changes will provide better healthcare, also to find new and sustainable energy and food resources. It will be a huge leap forward because changes can transform the way of living work. (Vijaykumar and et al., 2015) predicting that tools such as the internet of things, big data concepts increased the productivity of various businesses and the appearance of new business models. Also, a new context will appear as advanced production. To achieve it (Dusko 2015) in his research distinguished that it should be self-optimized systems. Integrating all experiences and tools in the planning system, the new approach as 4.0 can be completed.

To summarize what is 4.0 industry revolution, it can be called international changes, which will affect the different types of business, from the modeling and technological side. As Dusko (2015) analyzed in his research, the industrial revolution, in the beginning, was about water tool mechanization, but in the years, the main idea changed together with the innovations. In our days, 4.0 working together with the specific systems like CPS as mentioned (Navickas and et. al., 2017). All these changes are necessary regarding environmental changes and due to increasing highter production quality by lowering the entire organizational costs. 4.0 revolution is not a specific machine integration, its entire business model change, to integrate various systems to help to reduce human errors. Digitalization is a tool to use integrated systems to manage to receive real-time information. But to understand the real digitalization impact to the manufacturer organizations, it will be analyzed the author's research and discoveries about digitalization tools the impact the in depended variables which were described in (2 figure).

2. THE RELATIONSHIP OF BUSINESS SYSTEMS AND ORGANIZATIONAL PERFORMANCE

2.1 Digital manufacturing model

Manufacture is a complex, part of a supply chain element with different stages of planning, control, quality, and the final checking. The standards which have been before in the business strategy are changing and new technologies are revolutionizing and implementing in the supply chain management. Greef (2004) points, that the changes in leading manufacturing firms and the provision of competitive advantage, which is highly flexible and together with the supply chain is ensuring the best customer expectations. In the business field, the competitive point is the economy, reaching and receiving the demand to create the best service, quality comparing with the price and delivery time.

In this time, we are already facing the new industry changes with the name 4.0 revolution. Dusko (2015) is giving insights about technical importance and focus on human-machine collaboration. From Dusko researches, 4.0 is not a trend, it is a technical movement and it might be crucial for the future success of nowadays companies if companies won’t do any changes. It is the path of changes because all the manufacturing systems are integrating digitalization, robotization and sometimes lean model. But as (Daniel and et al., 2018) authors mention one part of the digitalization it is CPS. This is the hardest task because it needs an investment of a lot of money, may need to change parts to newer ones or may need to change the entire business model.

To meet the changes in the 4.0 industry revolution, manufacturing companies react differently and uses different tools, because all the companies’ final goal is slightly different. In the 2 figure on the left side, it is digitalization tools example, how manufacturing companies can improve their service quality, manufacturing performance. According to this model, it will be analyzed in my master’s work.

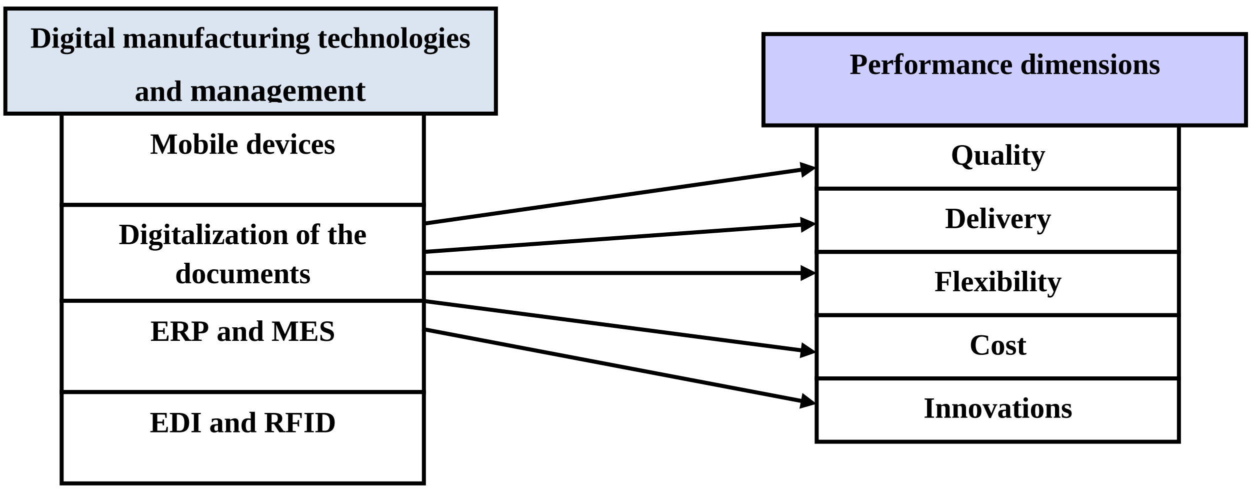

Figure 2. Digital manufacturing process (model made by author regarding model)

In the manufacturing company, the most important indicator is the demand. How much product should this company manufacture, to satisfy the needs of the customers? But firstly, by analyzing the company the internal indicators should work smoothly. Manufacturing organizations could implement the new digitalization methods and tools such as ERP and MES, or document tracking devices like RFID. Different tools have the ability to change and improve the business, but it all depends on the company's willingness to invest and try to create changes. The main research question is how the dependent variables such as digitalization tools can affect achievements performance or affect independent variables such as quality, flexibility, innovations, ECS.

2.2 Digital manufacturing technologies elements

To understand clearly what is digitalization, authors as Navickas and et al., (2017) explain and introduces that – CPS is a system, which is connected with the psychical world and working processes also collects information and data available on the internet. The main benefit of this improvement, it can radically improve the functionality of monitoring systems and reduce the costs of its implementation. Talking about supply chain, it could provide greater competitiveness advantage for companies.

But it is not enough just to install the CPS program as it was analyzed in Navickas and et.al. (2017). To achieve functionality and cost-reducing goal, at first there are steps to consider and accomplish: 1. Analyze essential elements of CPS; 2. Identify cyber-physical systems possible applications for 4.0; 3. Determine future trends of industrial sectors. 4. Analyze research results. That's why it is really important to consider all the surrounding factors and make the right decisions according to the final results because it will lead to positive or negative changes.

Considering the new name as modern manufacturing, it faces numerous challenges such: demand, mass customization which requires nonstopping implementation. As authors (Daniel and et al., 2018) analyze in their research project, the challenges exist in the availability of data, which is because of increasing digitization. Changes are visible in productivity, for example, a manufacturing system can be represented in real-time, by using digital modeling and receiving feedback from the digital sensors. And by using this sensor offline simulation analysis can be used to control manufacturing processes.

To analyze the real results of digitalization design importance in manufacturing, according to Popovas (2016) research, the author finds out that it reduces capital, modernization expenses. In Construction Industry Institute, JAV, according to study data, it was found out that Digital modeling of construction and installation, reduce 20% design costs, increase the pace of construction to 39% and increase the efficiency of production capacity by 15%. Digitalization information is accumulated overall manufacturing life cycle. The visual representation is in 3 figures.

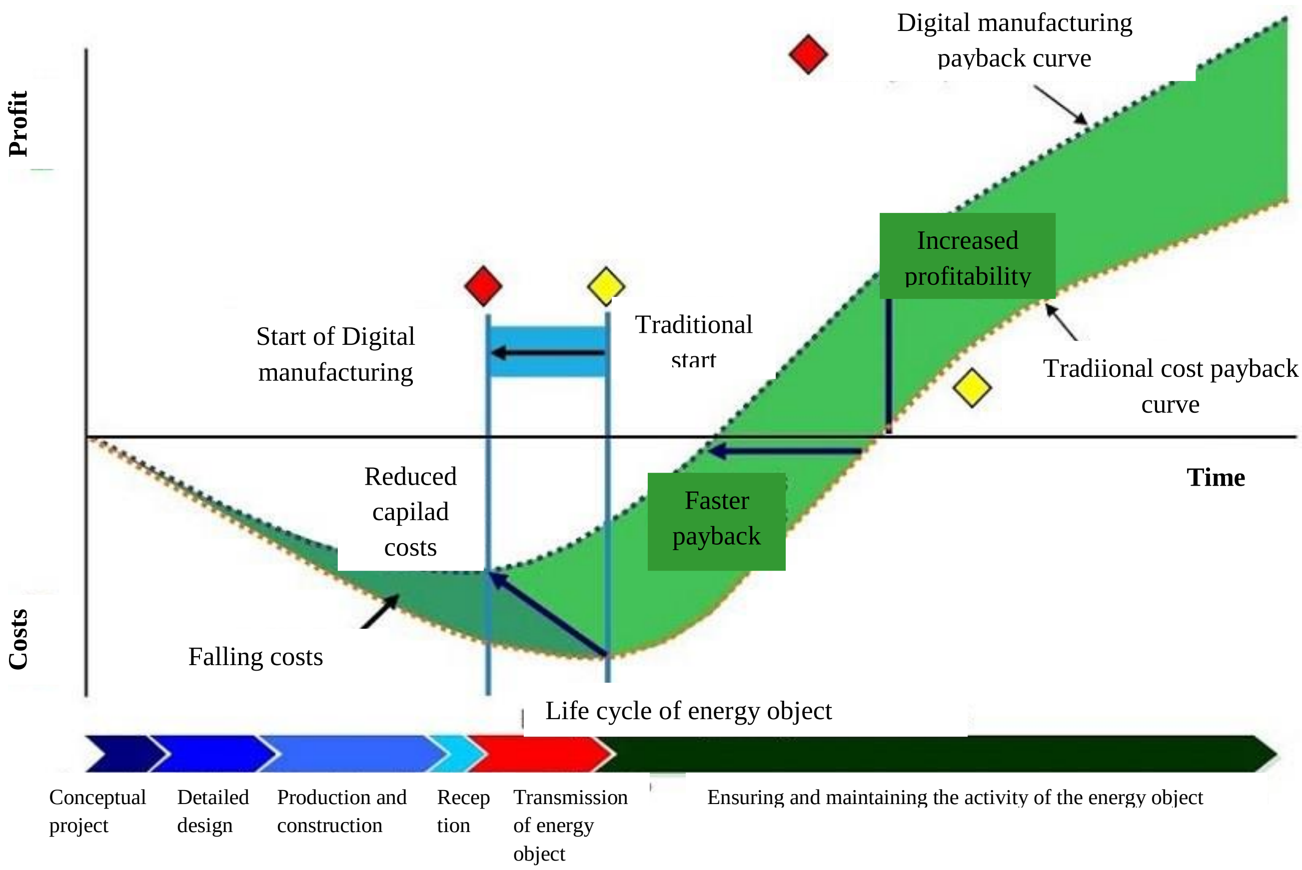

Figure 3. Comparance tradititional and digital manugacturing cost final result (made by author regarding Popovas V. (2016)

According to (3 fig.) we can see the differences between traditional and digitalization manufacturing efficiency by comparing the time and costs. Both starting points are the same, but the final results are different. Efficiency factor gives the most benefit because the main building will be used for many years, even decades. In other words, building complex management increase profitability allows reducing product prices or increasing manufacturing processes. The goal of digital manufacturing is a return on investments and profitability increscent.

In (3 fig.) digitalization has a different function that can be implemented in a company to create better quality or reduce the manufacturing time. One of the new sentences appeared about modern manufacturing, which means implementing in the process of various tools and systems like CPS, which allows achieving a better competitive advantage in the market. These new changes let the companies to succeed in the market or disappear. 4.0 is changing the entire business model which is from one hand help because organizations can look at the innovations from another angle – a support tool. Tools are just possibilities to achieve better results. In other chapters, there will be analyzed separately digital manufacturing technologies and their affection to the achievement's performance.

2.2.1 Mobile devices and digital documentation

Organizational performance has an important role to maintain all organizational functions. But the main issue that organizations are facing is that organizational structures are not designed or planned to move together with environmental changes. For the manufacturing industry, machines and documentation have a high role, because combining literature and practice, applying different strategies and looking if the aim will be reached (Sharif and Irani, 2012).

The meaning of the sentence mobile devices and applications changed in time because the technologies are moving forward. Mobile devices impact the dependent variables will be analyzed according to Columbus (2015) it can be described as:

- The platform: IOS, Android, or Windows
- Device type: tablet/computer or smart phone
- Manufacture equipments

The functions: information alerts, disconnected information processing, background processing are giving a different value to the manufacturing system. Dusko (2015) also adds that integration of the control system gives the innovation to the manufacturing processes and adaptation to the production. It would be automated assembly technology, for example, piece recognition, intelligent robots that can think themselves and security technology, which is called "Production 2020".

Basis of Industry 4.0 builder objects as authors Dusko (2015) and Daniel and et al. (2018) explains tools and systems with sensors and extra functions - intelligent controls are machines, plants or products. These tools are able to interface between machines, humans and exchange information among each other. The higher interface would be called software platforms as CPS. In the 2 table bellow, will be compared to different authors by planning importance to mobile devices, digital documentation.

Table 2. Planning importance to the manufacture organization (made by author regarding Daniel and oth.(2018), Dovere (2017) and Chan (2005).

Author	Function	Changes	Tools
(Daniel and et al. (2018)	Manufacturing planning	In capability, adaptability, and awareness, affect production output, machine tool	Cyber - physical systems
Dovere, Cavalieri, Ierace, (2017)	Logistic and Manufacturing planning	Production planning, maintenance; robotised or manual assembly; materials storage; stock control	ERP + CPS
Chan (2005)	Manufacturing modern planning	Development of sales and operations planning	ERP system

According to the first table analysis from latest year author Chan (2005), it shows that advanced planning which has an important role in modern planning can be included in different sections. Also, the author agrees that there should be applying methods which not requires huge modifications in the old ERP system. According to Dovere (2017) to create flexible manufacturing systems they require updates to the consistent logistical system and together with technical data, which is related to the tools, including production planning; maintenance; robotization. By creating automatized systems the level of tools in the results could be heavily reduced. Summarizing the 1 table with knowledge of Daniel and et al. (2018) implementing CPS and planning tools as ERP can be used as an increase in capability, adaptability, and awareness of the process because it could be used as a driven wheel for the effective production planning output. The standard protocols, which gather data operations of the equipment, can provide information, what changes are necessary.

2.2.1.1 Mobile devices and digitalization of the documents effection to the archievements performance

Each cycle starts with demand planning. In this part will be talking more about the quality and final results. In this part, the main problem would be strategic alignment, because it needs to create a company strategy and reach the final goal. It is difficult because it requires to invest a lot of research and time. Each company has its own activities and its own peculiarities. As explained by Chan (2005) "in the pharmaceutical company it operates mainly by contracts with a lead-time horizon of 9–12 weeks on average" (pp 163-197). In every company the planning time is different and according to, it needs to consider all the practical functions and the main target groups. From the functional side, companies can consider implementing various tools like mobile devices or digital systems to improve the service, quality or the main process speed. The main aim of this chapter is to analyze the hypothesis.

1 Hypothesis. Mobile devices and digital documentation have a positive impact to the quality, flexibility, delivery, costs, and innovations.

The first analyzed element will be quality. From the digital side to increase the efficiency of the productivity, companies use services and devices such: image capture, scanning of barcodes, even the voice commands. It is the way to implement systems and create better quality in the all process end. They are creating the importance of connection machines to sensors because this data performance indicator helps to create a digital strategy. Machines, humans, systems are like one wheel, which needs to work smoothly together, to achieve the company's goal. Sometimes the final result is not identified; it is given the freedom to implement new strategies or techniques, to find the way to better results. As it was analyzed in the first chapter, technologies, entire manufacturing systems are changing according to the need of the globalization. From this point of view, it is an opportunity to create a different and better business model than it was before. All manufacturing processes working side by side with the planning. So, every company should consider different aspects and the consequences. In (4 figure) will be compared 3 types of research what could be the results implementing master planning with the CPS system.

Navickas (2017), AI- provide recommendations for purchases, leisure in real –time. 2- insights regarding product purchasing

(Daniel and oth. 2018)- CPS information from sensors is sent to the transforming agents, produced from management and returned to the operators who control the machines.

(Chan 2005)- Master planning - made developing sales and operation plan. For ex: computer build company- performed every week. Ex 2 - oil refinery the sales plan can be developed every 3–36 months.

Figure 4. Quality modeling by CPS and mobile devices (made by author)

According to Chan (2005) in the fourth picture to make the quality results, everything should start from the planning. The other option is master planning which is based on the forecast for sales but together performs with the operational plan. The second part would be an integration plan in the system –document digitalization and implementing mobile devices in work. Daniel and et al.,(2018) from the operational side explaining that as data indicators, machines, and sensors, sends the information to the transforming agents, there are visible produced actions and decisions which returned to the operators who have the power to control the machines.

Every organization wants to satisfy customer needs and as the time is changing that's not enough with official hours as an organization is providing. By integrating all mentioned functions, an artificial intelligence assistance system might provide recommendations for purchases, leisure or other activities in real-time, which might be used for new product development (Navickas and et al. 2017). For example, one of the important criteria is service and product quality. Due to satisfy the customer, there are creating platforms, which can answer and lead to the right platform, to solve the problem at the right time and create better quality. The second - CRM system. Timing for sales – customers receive help when and how he needs it. A real-time response can make an extra plus to the company service. Quality depends on the system and the way all the work has been done.

1 Hypothesis. Effect to the Delivery

In this part, the main analyzed questions do the delivery was successful and did the entire product matched as it was ordered. Does the quality was excellent or poor from the delivery side? And the last one, what was the time period from receiving order till the consignee received it. In general, according to the authors, optimized manufacturing scheduling is a non - deterministic time problem, which can be solved by using different integration methods. But due to the complexity, scheduling and implementing challenges can be reached as the best possible solutions (Shuhui and et al., 2016).

Combining 4.0 revolution and suggestions to make documentation digitization and archive them in the system and to use mobile devices like computers and tablets, according to Vijaykumar, Saravanakumar, and Balamurugan (2015) we can call 4.0 innovative because it is an implementation of computers and human power. It is not enough just to talk about the changes, we need to find solutions or tools, which can make an impact on the processes. For example, from data source and research, it was found out that self-accessible systems, machines, and programs as cyber-physical might create a positive impact on the delivery process. The reason – because these tools can create computer automated control, whose goal is dynamic customization, reusability and on time importation.

Example from the warehouse and transportation sector as counted in the author's research (Navickas and et al.): for instance, a robotics company "Symbiotic" has developed a system to automate warehouse jobs and in this point reduce manpower. Instead of to use machines. The system cut labor costs by 80% and reduced warehouse size by 25%. This l innovation will affect not only warehousing but also the transportation sector. DHL indicated that self – driven vehicles which we can call a new technical innovation because at this point, a human is no longer needed. The vehicle is able to travel 24/7, the advantage of it is that it no longer needs to stop for the rest time, and there is no longer restriction about the sleeping time. With these changes, it also changing the laws and it is predicting that from the cost side to reach expenses reduction and to save 40 percent per kilometer (2017).

To make changes with the mobile devices in the logistics chain, (Navickas and et al. 2017), called it a shared autonomous vehicle concept, which mainly in the implementation of utilized vehicles. This concept integration as CPS usage in managing transport fleets could utilize the resources in a more efficient manner. According to author Powell (2013) research, delivery performance can be improved, if investors will consider increasing investments in specific sectors, which – support technology.

The second possible advantage by integrating mobile-based systems is to receive real-time updates from the production center as in the author example: four miles can be reduced off the typical order workflow, saving two weeks of production time. According to research, digital documents and mobile devices have a positive result in the delivery.

1 Hypothesis. Effect to the Flexibility

The flexibility is the way to describe the manufacturing company's reaction to the customer changes and in a higher dimension - to understand and realize separate customer's wishes. As author Dusko (2015) in his book describes, that manufacturing enterprise needs to analyze and predict the possible customers demand the products, illustrate and visualize it. With the help of automated processes, it can be achieved as a fast reacted final outcome. From the process side, it is marketing, engineering, manufacturing, and production line result. Costs are about the money and the choices which the company has decided results in which is going together with the impact of investments and created final expenses. (5 fig.) is about the stages and the final outcome.

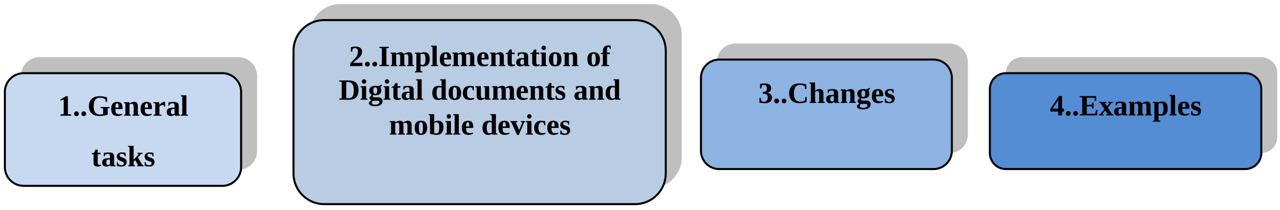

Figure 5.Implementing changes in flexibility (made by author)

A general task which is described in (5 pic.), would be automatization and the way how to predict the possible customer's needs and react according to it. The second stage would be the acceptance of new technologies as document digitalization and the implementation of mobile devices in manual work. According to Columbus (2015), a manufacturing company which is using mobility saves thousands of hours and dollars a year. The digital services and mobile devices used for supplier traceability and quality analyzation. Using online data to benchmark suppliers in real-time, it is like thinking forward. (Dusko 2015) provides in his research for example of a revolutionary online shop, which is a combination of services and information. EPLAN P8 has realized this idea with the implementing source of online-shop with adding additional information as e.g. dimensions, price, and 3D models, which is mainly used for visualization. As a result, planning and visualization gave a positive effect from the customers, which allowed more flexible movements in the progress.

Dusko (2015) also mentions that digital documentation includes many functions, which in the end can help humans to solve their complex tasks. For example, the goal is for different procedures to have functional abilities as self - automatization, configurations, and the ability to react to the interfaces. The higher level is self-diagnostic by implementing cognition tools. From the management side, one of the first highlighted elements is called control, because it is a process ensuring that all activities would reach the planned task. Another author adds, that control management (CM) for the third party would create the ability to predict costs and to find out the system, how to reduce the costs and increase the scalability of the manufacturing process. In this inner function, it is possible to leverage the available resources in the cloud to make it reachable at any time. The main advantage of CM is the ability to access the production data, which can be reached with any internet-connected device and availability of data anywhere in the world. This CM implementation is beneficial to the manufacturing industries. (Daniel and et al. 2018).

1 Hypothesis. Effect to the Costs and innovations

Forth part indicates more cost side and providing examples what could be the positive impact on the implementing digitalization of the documents and mobile devices. Columbus distinguishes advanced pattern detection, which can predict production costs and trends analysis (2015). According to the globalization, as due to changes, it increased the need for cloud manufacturing (Daniel and et al.. 2018). Cloud example - representational state transfer (REST), which is a web application that is used with web protocols, can be used through manufacturing facilities. From the functional side, it is simple to interface with cloud resources, that's why it is called beneficial implementation (Daniel and et al. 2018). The second example: manufacturer's start to use mobile-based sensors to capture data and report it in real-time. Columbus (2015) further explains why innovation is important. For example, mobile devices will be used to replace paper. Another example: mobile applications - sales reps give to customers allowance at any time 24/7. Also, they can request order status, delivery dates and configure order alerts that are delivered, anywhere in the world. The result: 76% reduction in order status calls to the enterprise sales teams and a 13% increase in sales the first six months these apps were available. According to the author's research and counting, I can say that digital documents and mobile devices have a positive impact on the flexibility and costs.

According to Columbus (2015) from the service side, if the company will deliver the quote for the first time, they might win 70% of the time. By using mobile integration, price and quote (CPQ) system, all functional sales processes can be done within hours of leaving the possible customer. Mobile devices and digital documentation can't change and improve organizational functional abilities without strict planning. To reach better company achievements, all processes should be checked, analyzed and if it is necessary – controlled. Mobile devices are tools to help to reduce mistakes and make all processes more automatized. Digitalization together with digital documents is a system to receive real-time information to make all action visible and easier to reach. Analyzing the author's research, by cutting costs it could give a positive impact for reducing the cost and minimizing the warehouse's space and extending the driving time. It is working together with information slow in the company operational system. Mobile devices and digital documents have a positive effect on organizational performance.

2.2.2 ERP and MES

In this chapter will be analyzed different author's researches about ERP and MES, their functions and the main advantages and disadvantages. The main research question, how these systems affect achievement performances in different sectors, like quality, delivery, time?

To understand what ERP - commercial software system, one of the main functions is the information flow. In the company, it can provide financially, gather information from the customer. Human resources are about the employees or the main function of how the work is going on in the supply chain. This system can provide seamless information integration in company activities. But before, ERP has its own history.

Table 3. ERP history (made by author regarding Powell, 2013)

Developed ERP can (MRP in 1970 –goal planning, inventory accounting, and purchasing	1980s (MRP II) was born when added financial	1990s. integration of planning, management and the use of all resources	Now. Data base - financial, human resources, supply chain, and customer information

In the (3 table) is shortly provided about ERP functions, what has been done with this system model. The beginning was in the 1970s, this year we can call the development of this program. The main focus was on the company's inventory counting, material planning and the results of the purchasing. The changes were made in the 1980s when next to planning was added financial accountancies. The definition of existing ERP appeared in the 1990s as management planning of all existing resources. This research was done by Powel (2013). The benefits of ERP systems can be categorized into the following (6 figure.):

Operational control | **Management control** | **Strategic planning**

Figure 6. Organizational control methods (made by author)

To create quality, the ERP system should have open system architecture is showed in (6 fig.). This means that any module should have the capability to be interfaced or detached whenever required without affecting the other modules. Another author adds that planning modules such as long term, middle and short term, shall provide elaboration, together with the main four operations – distribution, sales, production, and procurement. It is working together with the decision-support database to reach the best result with all gathered information (Chan, 2005). Even Dusko (2015, pp.1-14) expressed it as "The revolutionary new Industry 4.0 about the ERP, it is not the cloud or network of communication".

Starting explaining what MES, is first, it is important to understand what function it s integrated. As it was mentioned before, planning is an essential process in a manufacturing company and its given high-level control importance of monitoring production data. According to Daniel, MES could be described as a manufacturing execution system, which records material input, how much material, time and workforce need to be consumed in the process and in the results, we can see the product quantity and flow. An MES is not just a tool, but also a system, which can count and predict long-term data trends on production efficiency. In this process, there will be considered how much raw material needs to be consumed and the final number of parts that can be produced (Daniel and et al., 2018).

From the functionality side - MES with the connectivity from the mobile device's sensors has additionally identification and indoor location. Other opportunities, to include augmented reality applications (Daniel and et al., 2018).

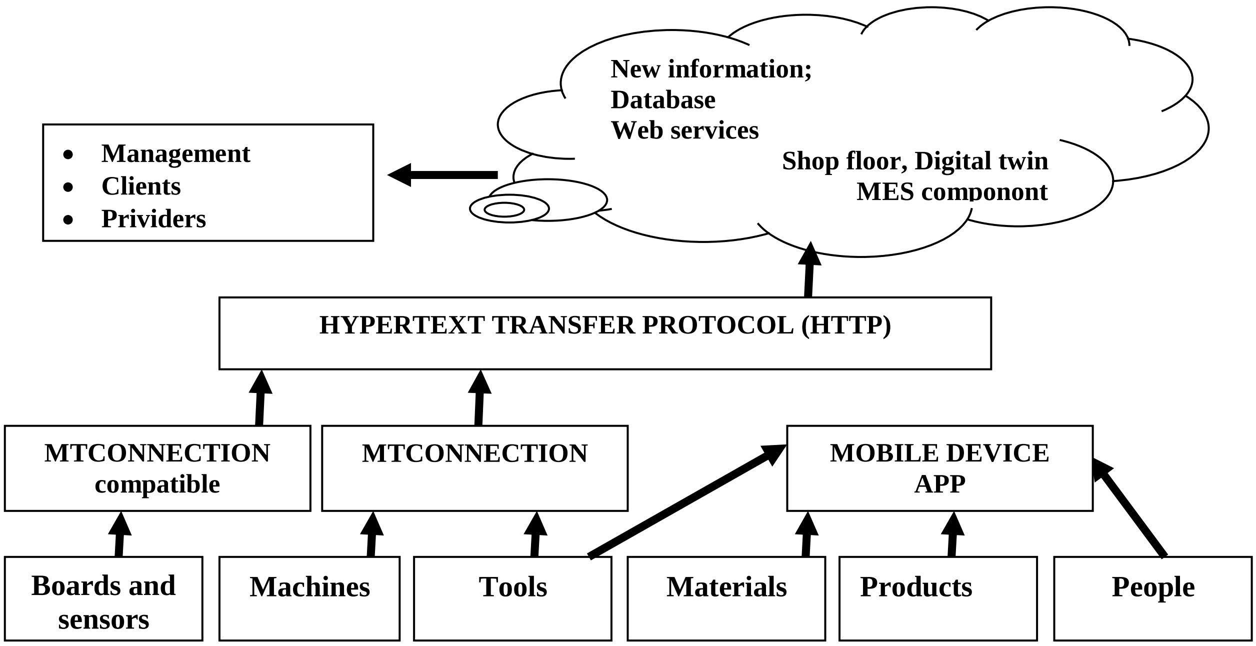

Figure 7. The shop floor, digita Twin in MES,(made by author regarding Daniel (2018))

To explain how the MES work, we can see in (7 fig.), there are different devices as machines, people, and sensors. Authors (Daniel and et al., 2018) explains, that the data from the MES app is sent to the cloud which's stored in the database, connected with MTConnect and all information received from the networked machine tools. When a new product is initialized using the MES, the app sends the information of the new product to the remote script using REST, so any manufacturing information is connected and can be reached through the cloud.

In other words, the main function is monitoring process output, how much should be consumed through usage, and the final productivity. ERP as the system is assigned to the higher, upper level. One more advantage in the MES as a system, it can be adapted as a considered link between these two realms, such as information flow, planning and the information gathering in the current time. In the (3 table) is comparing MES and ERP facilities and similarities.

Table 4. Comparison ERP and MES (made by author regarding Daniel and et al. (2018), Gupta (2008)

	Advantages	Disadvantages	Similarities ERP+MES
ERP	• Customization • New system / business model • Planning	• Customization is limited • Re-engineer business processes	Advantages • MES accompanied by ERP • Need hardware
MES	• Including 4.0, decentralization, mobility, connectivity, cloud integration • Sensors information • Flexible, low cost starting point	• interoperability and data sharing • manual data entry • for large enterprises	Disadvantages • do not address the information needs • may not integrate data analytics

From the ERP side in (4 table) the main advantage in such a system is customization and unique business model which include planning and deploys. The ERP system in which the company will be adapted will be just only one comparing with the other companies (Gupta, 2008). But every coin has two sides and an ERP system is not an exception. Here are a few disadvantages of ERP systems: customization is limited in specific sectors, first in a report and presentation of information. The second sometimes is one of the most important, they need too even reengineer their business processes. This system disadvantage might become an advantage because this program installation might lead to specific changes such as to look at the new view and leading to the new direction (Gupta, 2008).

Looking from the description of MES, in the current situation, this system is designed for more large enterprises than small ones, because the function can produce large quantities even of a small number of parts. Having this system in a small company with big quantities and fewer variables in production, this MES system function wouldn't be used fully. As in the third table which was made according to Daniel and et.al (2018) researches, can be compared the disadvantages with the current system: the main need is to receive manual operator's data entry, which is working with lack of near - real-time capability, and possibility of data sharing between different elements. Sometimes it is not enough to use just one program, regarding research, the main characteristics of MES are suitable to work together with 4.0 industry, which is giving the capability to the mobility, creation of decentralization, connectivity and the new method of cloud – information integration in work progress chain. The main advantages would be sensor information and digitalization and it is possible to be flexible and lower costs.

ERP – planning and strategic tool, with a collection of various business processes that simulates the real business functions and provides integrated information in all the required places and appropriate form. MES – manufacturing data integration system model, which can have a positive and negative aspect, but it all depends on the business and resources. I can say that any tool can help to achieve the goal, but all the time it is different and complex. Integrating both systems have pluses and minuses. As we can see from the fourth table, the right side, pluses would be cooperation and combination, also it is not necessary to enter the same data twice (Gupta, 2008). Minuses – with the right time information flow and the needs of individual employees, and the second how to correctly integrate data analytics. In the second chapter, it will be analyzed systems affection to organizational achievement.

2.2.2.1 ERP and MES have effection to activities achievements

Manufacture systems - planning and integration tools, helps to reduce time and increase profitability. From the production, side to ensure quality and functionality. ERP, MES can be combined with the TQM model. To create quality for the products, it is not enough to add one step; it is the line of all manufacturing functions, starting from the planning, operation, and control. This chapter main research question - do these systems have a positive impact on the activities achievements:

2 Hypothesis. ERP and MES have a positive impact on quality, delivery, flexibility, cost, innovation.

Enterprises may already be using some IT infrastructure to reduce expenses such as: (cost, strategic reasons). Many time quality and the delivery can be a high level, but implementing changes, it can become even better. Investing money and time, in the future, it can give a high impact. The main business function is to find and create the right model to satisfy the customer's needs. The first analyzed element will be quality, which is described in (8 figure).

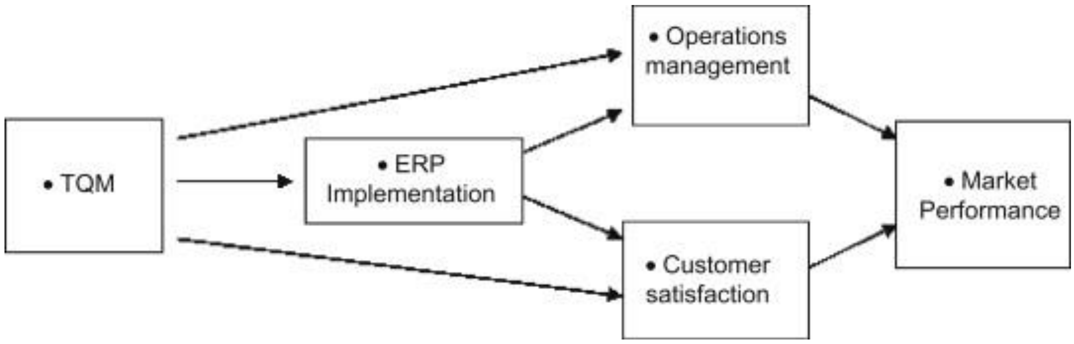

Figure 8. TQM and ERP implementation - a conceptual model used from authors (Li, XU Markowski, 2008).

TQM usually used to make necessary organizational changes, do to improve all business processes. From another side, systems can fulfill each other by different abilities, its cultural framework and a foundation for ERP implementation. As it is shoved in 8 figure, according to Markowski (2008) ERP is a process-based technology initiative and according to authors researches, implementing an ERP system requires changes in all processes or at least in the part of them. ERP can be implemented in a flattened organization, also can offer direct communication between separate channels to reach various functional groups, and the process would allow reacting quickly to the needs of the market and the customers. Another author adding, that the main quality operational advantage of an ERP system is improved operational control can offer: reduced operating costs by better planning (improved resource utilization), lower inventory control and the result would be better visibility and efficiency (Gupta, 2008).

From the MES side, it fits more in the larger companies with various type of production. As Daniel and et al. (2018) explaining how this system would affect manufacture product quality, that MES built quicker reaction to the working manufacturing processes, which can be controlled through app. Second step – can be reached by using cloud data information and the main ability - computing capabilities. Finally, MES integrates with computer numerical control (CNC), which is a machine tool and using a higher platform MTConnect standard to receive real-time information according to planning and control. This created system Shop floor digital twin, used in manufacturing companies to ensure integration between separate processes and combined with the information, used for augmenting MTconnection data collected from the manufacturing equipment. So this program has a direct impact on the machines in the manufacturing process and can ensure the quality control throw data apps.

ERP and MES are different systems, what benefits they have and better to use tem separately or together.

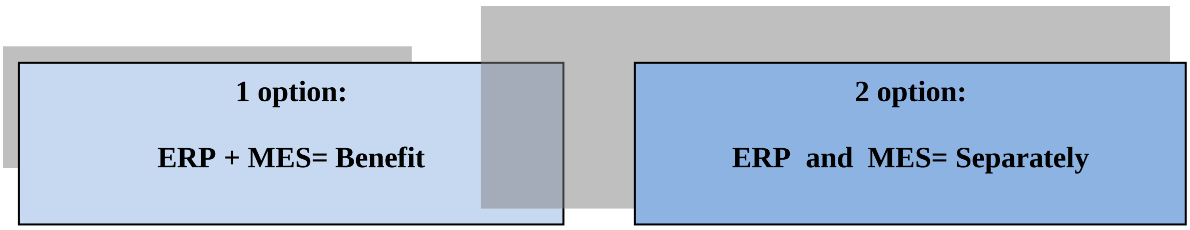

Figure 9. ERP and MES partners or separate systems (made by author)

Looking at the (9 figure) ERP and MES could work as the systems separately and together. According (Daniel and et al. (2018) research, he is mentioning that was found out developed MES, first it was tested in a small volume search to evaluate its performance in a production environment. The features provided that by the MES can create low cost, universally available, near real-time information to take action and solution that adds additional value to machine-produced data. This is giving positive feedback about the quality to the time and the product. Using other systems as ERP can be created a wealth of valuable process. Also, the author adding that the combination of MES and MTConnect, can evaluate machine efficiency and provide analysis of raw material movement to the final product. All the production line would be clear and can analyze the time, all the issues which happened during manufacturing time. This tool providing information and analyze the opportunity.

Starting from the implementation of ERP as authors analyze, need to have many resources and consideration if it will fit in the company and it will create a unique business planning model. MES system can reduce the cost and combination of human-machine and real-time information about the errors and possible solutions in actions. This will help to create and control the quality of the product and ensure a long-lasting business model. I can say, ERP and MES giving a positive result to the manufacturing quality process.

2 Hypothesis. Effect to the Delivery and flexibility

In this chapter will be analyzed the authors researched and opinions about the ERP and MES influence on the flexibility and delivery processes. Systems have more positive or negative feedback. Starting from the beginning any functional integrated into the system can be the right tool, or method if the company knows how to use it. Implemented ERP planning system, combining it with MES and IT could, which can provide information on any time and place, ensure reliability and trustworthiness. It is all depending on the calculation, timing, and action how the problem will be solved.

To create the right organizational functions, we need to start from the planning. Chan pointing that such as the production process model (PPM) establishes a connection between the manufactured products and customer order. Then the company can count how much material they need, predict the manufacturing time and create the delivery schedule. The planning system, according to the author, can be presented as a "hierarchical tree, on the lower level of which apparently there is a technological operation" (Chan, 2005, - pp 163-197). Product is the final result, but the manual work inside the company is considered a fact. Let's analyze how ERP and MES systems can affect supply chain delivery and flexibility.

One of the suggestions to make an impact on the delivery, integrate ERP with a lean model (Christopher, 2005). Other authors adding, that to make a wider impact on the supply chain, using lean production, it should be implemented together with the information technology, as says Powell in his research (2013). For example Robotic Process Automation, which could reduce manual work and provide more efficient resource utilization in various areas (Navickas and et al., 2017). Also, the author adding that information exchange without human–machine–human interaction would not be possible to achieve higher goals for the organization. This delivery ensuring link and allocate its resources in the best possible manner, and control them on a real-time basis according to Gupta (2008).

From the flexibility side Gupta offering that ERP should be able to run on different hardware and databases to use the company's heterogeneous collection of systems. So the ERP can be modified when it is necessary. Dusko adding, one of the main Industry 4.0 idea - high-developed machine and human collaboration and interfaces. Production 2020 is conditions that person and machine as e.g. robot systems can co-operate adaptable and secure in the production sphere with each other, without restrictions (2015). Bus analyzing the MES system, which is accompanied with (ERP) system, can cost a large expense to a manufacturer; this is particularly problematic for small manufacturing enterprises (SMEs) whose ability to afford such systems may be limited. Another important aspect in an ERP solution, but unfortunately most of the current ERP solutions lack it. For example, with an ERP package like SAP, Dynamics AX allows changing anything you need. Businesses see this as a wonderful feature. This is the key for the ERP you implementation (Gupta, 2008).

Summarizing theoretical knowledge with practice, in the delivery process is really important the quality of the product and does the company worked in the time frames and had the right product in an urgent time. Order from various customers may contain a different number of items and products. Looking from the marketing side, we need to predict the changes in the orders and to be prepared to act After it is considered results how all manufacturing lines worked, starting from receiving the customer order to the final delivery organization. Using MES, all manufacturing functions can be check throw the tablets and computer and using ERP, plan all the process and impellent changes if it is needed. Using these tools, it is possible to react quickly, check the production quantities and predict minimize the time and production costs and make all functions more flexible. ERP and MES have a positive effect on the delivery and flexibility.

2 Hypothesis. Effect to the cost and innovations

Every single system costs differently, it is depended on the company need, structure and how innovative it should be. That is why companies are based more on the sales plan, because than the companies can predict the manufacturing need for production quantities and count the possible margin and profit. In this calculating process, includes the optimal: price, speed of delivery, reliability of supply, quality of materials, etc. In order to plant raw material development to the final product, I'm using Chan (2005) example, that the computer build company makes or corrects plan every business day and set ordered parts and materials if they meet the strict demand. Talking about MTConnect data and MES data usually reside in separate systems that may be proprietary and expensive. From the ERP side, Total Cost of Ownership (TCO): is not just a tool; which could take several years to implement. The TCO does not only consist of ERP product cost and customization cost, but it also includes the cost to bring about cultural changes in the organization (training, etc) (Gupta, 2008).

Everything depends on the production quantity, material, added value from the technical side: systems implementation time, visibility and innovation models. The management side could be called the wheel because just from the site can come new changes and organized training Regarding Greeff, 2004) research, the author opinion is - without a good implementation philosophy and research, just very few systems can add any real positive impact to the organization. In other words, we can call it as innovations. In 21 century, many organizations are saying that speed is one of the most important criteria because it gives an advantage against the competitors. From ERP and MES side it would be the manufacture system innovation because it gives the unique business model specific just that company and from these planning and operating systems, can create affection to the speed of the new products releasing and specification. According to the author’s researches, I can say ERP and MES have a positive effect on the manufacturing cost structure and innovations.

2.2.3 EDI and RFID

In the first chapter, it was analyzed the importance of planning, management work, an organizational performance due to creating a positive result in the production of customer satisfaction. The major goal of companies is to be competitive in the market. According to the Choudhary and et al. (2011), it is becoming global competitions and according to economic condition and market place, it is becoming more demanding. So the meaning of the competition to become more strategically, customer and technology-focused. From the functional side, it was described mobile devices, which can be implemented to reduce manual work and make all processes easier. By implementing digitalization, we can see all manufacturing functions in digital form and creating digital documents, which can be shared all around the departments. After if the company is able to implement systems as ERP – planning system or MES manufacturing process, which creating information cloud of the sensors results. But sometimes it is not enough if the company wants to have full knowledge about inside processes in real-time. In this chapter will be analyzed real-time manufacturing and control systems, RFID and warehouse management and control system EDI. These systems function is different, that’s why I will analyze them separately.

EDI is a system and in full sentences, it is called Electronic data interchange according (Choudhary et al. 2011), it is an international explanation. EDI system also becoming global as RFID, because of business activities and transactions between the networks. In other words, it is a faster document and information exchange. As usual, programs have barriers to success in organizations. According to Minjoon and Shaohan (2003), there are 7 classification categories: technical, because of need technological implementation, then human resource. From the management side acceptation and good leadership, by creating trading relationships. As a result, creating a system, which would ensure security and all investment costs become a benefit in the company. Talking more from the technical side, difficulties include in the implementation process, because of the system's instability. Implementing new systems might be new protocols, procedures required, which can make temporary errors.

Everything has negative and positive sides. Analyzing EDI, quality standards can be reached by implementing various strategies and methods. Chan and et al. (2010) in them researches summarized other authors find about the positive relationships between various elements. For example, from Kim et al. (2006) find out the positive results between information exchange and market performance and this can create sales growth. From Larson and Kultchitsky (2000) - combining information flow with lean information integration can create a stronger connection between buyer and supplier because then communication will be faster. To understand better what is EDI, functions and seeks can see in 5 table.

Table 5. EDI functional comparison among the authors (made by author)

NR	Authors	What is EDI	Elimination	Functions
1	**Choudhary et al. 2011**	Office exchange of documents	Volume of paper requirements	Electronic purchase, Advance shipping order, Invocation.
2	**Chaoon and et al., 2010**	Inter-organizational communication	Forman and informal agreements	Sharing information system, alignment
3	**Jardini; Kyal; Amri, 2015**	Way to transfer business documents.	Lean manufacturing, waste elimination	Logistic information optimization
4	**Lee and Lee, 2010**	Data, document interchange	System control frauds	EDI control, management systems

Starting analyzing the (5 table) from the first graph, Choudhary and et al. authors explaining EDI as interoffice electronic documents recording and exchange, which allows to reduce paper requirement s and make it in digital form. This saves time because can do various procedures as a reminder of money transactions, provide transportation documents. Chaoon and et al. (2010) adding that they seek to create a communication system by coordination information and material flows. Creating a different communication and strategy planning, like alignment. In the third graph, Jardini agrees that EDI is a tool to transfer documents and the main seek to reduce time in the logistic information chain and still analyzing what changes could be done to minimize waster in the manufacturing (lean) process. Summarizing (5 table) with the fourth graph author Lee (2010) opinion, that EDI is a digital system, which allows up to share and receive documents. Really important point it is that companies should have a good protection and control system, which might allow in the future create different logistic business model, not a secret one, but company's alignments.

The second system according to authors Jacob and Thiemann saying, RFID devices become one of the most numerous manufactured devices worldwide, because of the functional abilities. We can see many examples all around us, like cards, money cards, product labels (2017). Other authors (Dovere and et al. 2017) adding that this system could become the primary technology for tracing various materials. It can become a long term benefit against competitors. The main question is what the main advantages of this system are, why it is better than others and how it can help to the organizational performance? In this question answering Zelbst and et al. (2012), that the main efficiency what can be reached to the organization, by lowering the total costs in goods production and service. It would be reached by eliminating the waste and fully or partly utilizing having resources.

Considering the point is the functional abilities and what changes need to do before and after implementation of an RFID system, Dovere and et al. (2017) note that changes must be done in tool management processes, revision in machine centers and installations in different reader's positions. After the changes, it should be created an interconnection between the tools, machines and supervisor software. But the Xiaohua; Tiffany and Qiang (2018) distinguished the negative side, how to gain value from RFID original data? We need to invest in creating and calculating the model, then the value according to the results can be created. It can operate not only in material, vehicles but also in logistics, production process. Authors mentioning one more point to consider, how to unify and measure the real problem from gathered data and remove it? To understand better what RFID is and what function this system can have, can see in the (6 table).

Table 6. RFID classification (made by author regarding authors mentioned in the table)

	RFID analyze		
NR.	**Authors:**	**Type 1.**	**Type 2.**
First	**Jacob, Thiemann (2017)**	**Low frequency -** connected to coil antenna. It can operate in primary magnetic field. No so sensitive near metals and liquids.	**Ultra frequency -** working with multiple folders open dipole. Is more sensitive then LF magnetic field near metal and liquids.
Second	**Fangming et al. (2018)**	**Chip based -** have sensors which are in the tags. It can show high data and coding abilities	**Chipless -** can be implemented as tags, traceable. Surface acoustic wave(SAW)

Analyzing what is RFID in the (6 table), I find out different 2 categories according to the first author, how the same device can be called. The first category according to the frequency: low or ultra, this is the main distinction about the functional capabilities. It would be sensitivity to the outside material and working capacity. According to the second authors Fangming and et al. (2018) researches, RFID can be a chip or chipless based group. The main difference between them that chip-based has a tag and in the tags, there are sensors, which are connected by an informational antenna. As the authors analyzed, this chip-based has a high-level coding capacity, by creating working abilities for constituting wireless sensor networks. Frangming distinguished one fact, that chip-based sequences are costly to the organization, because of the need to create sensors network, which will be not suitable for the low-cost warehouse of goods. From the functional side, the tag movement in the organization we can see in (10 figure).

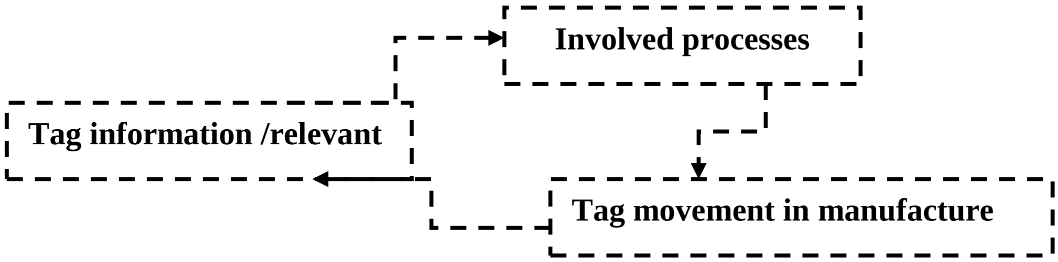

Figure 10. Tag movement in manufacturing (made by author)

Analyzing (10 fig.) and Dovere (2017) mentioning the steps, first would be marking, giving a specific tag. Every single product has a different marking and tracking systems. Tag is information about the product or tool, has its own specific code, which contains technological, material, even geometric description. The second step, involving different processes: search and selection of products or tools, data entry operations, it might be machine entry operations. It is creating life cycle operations. Xiaohua and et al. (2018) from their researches adding, that's an existing logistic node, which is fixes on RFID, the product with the tag can be traceable in the manufacturing system if it has the electronic product code (EPC). But coming back to the tag information, it is still relevant as adding Xiaohua, this system can reflect just object information, but not about the logistics processes such as time, quality or location.

RFID is a system to track the various tools, products in the manufacturing, logistic chain, to act immediately if it is necessary. This system becomes a need for globalization because, from the functional side, it is implemented in many tools like debit cards. Tags and barcodes have their own identifications about the production. The system model is based on the calculation of the received data and trying to improve functional abilities. According to authors Zelbst and et al. (2012), they found a positive correlation FRID technology utilization and financial, cost performance. Authors adding that sew a link between efficient outcome and return on investments. Also pointing, that one technology not always can directly improve organizational performance. Many times need to use extra systems. In the second chapter will be analyzed RFID and EDI affection to the activities achievements.

2.2.3.1 EDI and RFID have affection to activities achievements

Sometimes the answer is in front of us, but we can't see it. Author pointing knowledge of control by two elements: the knowledge content, what it is and the second to understand what is for and the main importance (Lee, 2010). Analyzing RFID, which is the automation of internal logistics and EDI – digital exchange of data supply and customers, we can see just sentences. Organizations start to understand that there should be changes and cooperation alignments might become a method to create higher quality customer service. (Choon et al., 2010) distinguished that exchanging companies and partner's technology, collected data, might become the capability of easier communication and collaboration. My research goal to analyze other authors researches regarding affection to achievements performance. To analyze if my opinion is correct I will research does RFID and EDI can influence organizational performance. I will research how warehouse and communication systems influence achievement performance. I will start to analyze from the quality.

3 Hypothesis. EDI and MES have a positive impact on quality, delivery, flexibility, cost, innovation.

The production, service quality can be created in different ways, it depends on understanding how and what methods it can be created or reached. Control is the critical aspect, how the quality and results can be created. In the organizational performance it can be divided into 2 categories according to Lee (2010):

- Internal - human behavior, operational procedures, process changes and standards, accounting or sales, network, communication interface.
- External - third part (trading) - security threats, telecommunication, trading partners, technical elements.

Every organization can find operational and competitive benefits from the high level of knowledge of implementing systems by knowing how to do it. From the practical side, EDI is not just a system; it is going together with the 4.0 industry revolution, with the technical flow. It is connected with the internet and IT sector. From the beneficial side, it is like an information-sharing portal, connected with specific channels, trading partners. It is creates increased vulnerability. In the same way, the created control system, with ensuring security by creating methods avoiding critical transaction processes. According to Lee and Lee (2010), processes become more integrated into the network and it becomes more closely linked and automotive, which ensures organizational effectiveness and integrity of information. Another author (Choudhary and et al., 2011) adding that this EDI system reduces transaction time, entry activities and improving response time. In other words, this system goal is increased speeding time of data transfer.

If EDI is system and method to create faster information sharing and flow between the organizations and the partners to increase faster supply chain work, so RFID is a system based automated process, as identification tags and machine tools to improve manual processes. (Dovere and et al., 2017) identifying the automation process as an optional quality way to reduce operational work and possible human errors. Saving time and the material, according to the Dovere, the benefit is economic savings.

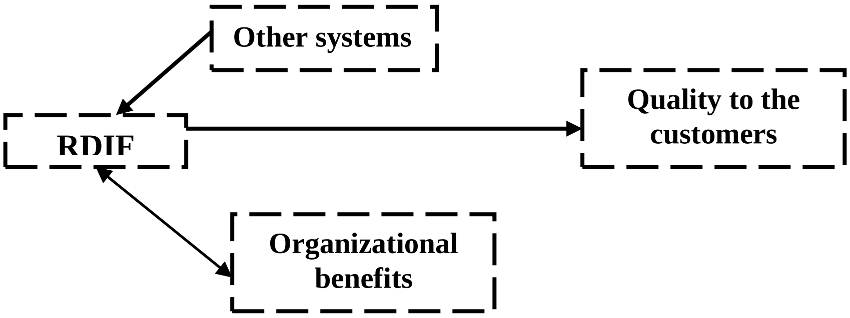

Figure 11. RFID quality creation (made by author)

As it was mentioned before, quality can be different types, a product, service, satisfaction, operational quality as we can see in (11 figure) RFID is a system, which in distance can provide information about the quality, real-time control, and operational functions in the organization (Xiaohua and et al., 2018). Using this system, time, location, an event the quality of the product is known, which used in manufacturing management we can reduce uncertain errors. In other words, logistic information in organizational performance is visible and can be controlled. RFID can work also with other systems like ERP and creating capabilities to combine purchase and selling processes through the supply chain. It is a possibility to reach the effectiveness of both the manufacturing and the supply chain organization (Zelbst and et al., 2012). From the author's researches, the main organizational benefits can be reached reducing operational and logistics requirements in material flow, and creating just in time and place schedule. From the customer perspective, if they are satisfied by the company, they will continue buying and recommend the product to the other persons or the companies, which will lead to increased profit to the selling organization.

Real proof from the practice and researches is the best evidence than can be found. According Chan and et al. (2010), Sanders and Premus (2005) research about EDI, authors found a positive relationship between IT capability and performance, and the results were measured in costs, product quality and the manufacturing time. As it was mentioned before, the importance goes to the cooperation and creating the alignments between the companies. Jardini and et al., (2015) adding that supply chain optimization and synchronization between the physical and the information flows allows creating business interaction in the global context. In Zelbst research was used other author (Lim and Koh, 2009) findings, that implementing RFID, that organization in business performance can able better satisfy the customer in time and response quality, which in result improve organizational performance. From the EDI side, increased information from outside the company can create smoother communication between the organizations, and increase organizational performance in the inside of the company, ensure the creation of the various quality. This creates better organizational and customer performance and bonding. The main importance of the companies to have similar information-sharing equipment to allow exchanging EDI documents as fast and simple as possible.

3 Hypothesis. Effect to the Delivery and flexibility

Business model changes, the same in logistics, delivery sector. Appearing new sentences – just in time, which means creating more often flexible delivery schedules, manufacturing fewer products according to the demand. According to Jardini, Kyal and Amri (2015) many organizations have limited flexibility and bad time response, which creating poor relationships between the organizations. Authors making a fact, that the EDI system can make changes in supply chain making positive influence the JIT process. Implementing this system, also changing from the old model to creating the new one, because seeks to improve estimated conditions. Looking from the other angle, in the business sector there are so many suppliers, if the service is not provided at the highest level, it is not so hard to find other replacement company. From the EDI side, digital documentation and information flow creating a huge role in the business communication and creation, because then all processes can work smoother and in time.

From the technical side, RFID has its own role in the delivery process. Goods, tools and all shipments can be traced in the manufacturing place or on the way to the customer. As Dovere and et al. (2017) adding, that shipment can be multiple and we can in distance read all the information about the production. In the logistics sector it is really important to know where the shipment is when will be done collection or delivery. It is like a nonending chain of communication from the organization with the customer. Using the RFID system can be improved shipment traceability in the entire supply chain and making easier checking and counting process. One of the main advantages of this system – reduction of the inventory and potential error handling.

Inside in the organization process as RFID, which has a function to mark the shipment and after it can be tracked in all supply chain. The main benefit is easily traceable in the system and in digital form all information about the shipment is provided. After the shipment is ready, there is a planned delivery schedule. Cooperation and communication with the customer can be reached smother if both sides will receive just in time response and needed information. To make easier and faster communication and information, document flow, the system as EDI can ensure it according to authors' research. The documentation process is one of the ways to make work easier not harder, that's why all business models are changing.

Flexibility

Changes might become a barrier to flexibility. The main reason is that that might change organizational values, behavior, increasing new tasks. It is coming from the human resources, management issue (Jardini and et al., 2015). EDI is a system, which will make changes and new implementation in the system. New technologies fulfilling organization, but need time to adjust to the new things to make it successful. Jordini adding one example from the Toyota production system, the company uses JIN and lean systems. The author mentioned that EDI provides a fast and efficient way to transfer business documents, which making a faster production process. The visual view can be seen in the inventory level. Looking from the informational side, implementing EDI, control of the documentation is increased as also the transfer of the document s speed (Lee and Lee, 2010). It is creating less risk for data errors. The old modes changing the new ones, but the processes not going to be done overnight. As around the business sector, there are many suppliers and they all require different capabilities. The system as EDI, has a potential in the future, to become a flexible, innovative system, which will be used in many companies (Chaudhary and et al., 2011)

Different technologies and systems have various influences on organizational achievements. RFID is like a niche technology and many companies are adopting it. One of the companies experienced success and positive results, others unable to use it (Dovere and et al, 2017). The tracking system can be chip-based or chipless with the tag sensors. Chipless based tags are low costs, with high reliability and can work even in a harsh environment (Fragming and et al, 2018).

Table 7. Kanban analyze and structure (made by author)

NR.	Author:	What is Kanban system	For what?	How it works?
1	**Mackerron and et al., 2014**	Coding system	Manage production	Code materials and parts
2	**Xiaohua and et at., 2018**	Record system	Manage production	Identification sheets. Records. Shortage information
3	**Jinwen and et al. 2014**	Monitoring system	Monitoring material flow	Code material with RFID

The Kanban system is more adapted in the manufacturing system to track record and code material as it is described in (7 table). Both authors Mackerron and Xiaohua agree its system mainly used to manage production flow, with the ability to control it. Data collected from manual records and from management place put in the Kanban system. Jinwen in the third graph in his research analyzed the kanban system together with the RFID work and implementation. Adding that to implement a barcode system, need also the scanners and technical equipment to make the manufacturing line more effective. But in the process, the warehouse and logistics system after become more flexible and saving operational time. The RFID technology is very helpful to collect data of logistics operations, but it can’t track anomalies directly.

To create flexibility and smooth delivery process, we need to invest time, effort and researches. According to many authors’ types of research, EDI as a document transfer system can make positive results in flexibility and delivery as well as RFID – tracking and monitoring system. But from the organizational management side, to implement new technologies need time and patient. The result might be saving time in operational performances, faster communication, and tracking system. Every organization has different abilities and capital, how much money they can invest in the new systems and technologies. The next paragraph will be about how EDI and RFID influence cost and innovation.

3 Hypothesis. Effect to the Cost and innovation

Comparing separately technologies, many times cost and simplicity are really important chosen for the companies. In the same time, innovations are changing and moving ahead to create something new and useful. Investing in some tool, program or system is a challenge because it requires new implementation and resources from the company. One of the examples could be capital and money how much the company should spend on the new innovation. In this paragraph, I will analyze 2 systems, RFID and EDI, how these systems affect the company from the cost and innovation side.

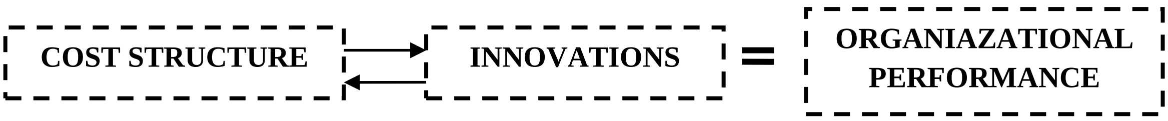

Figure 12. Cost and innovation affection to the organization (made by author)

According to Dovere (2017), RFID as technology reaches high interests comparing with other technologies and systems. It might be because radio frequency adopts zero power modulation, it is simple to use from the architecture side and lower costs compared with the same type of systems. From the practical side in manufacturing companies want to improve supply chain capabilities and communication with the chain partners to reach higher information exchange. The final outcome would be the time production of goods or service creation at lower costs (Zelbst and et al., 2012). Production planning goes together side by side with waste elimination. It is important to contribute raw materials with the work process to efficiently manage the amount of waste. Planning and reduction of waste saves companies assets and improve production planning and organization.

As business models changing, as well as companies, try to find the right way to cooperate with each other. As (Jordini and el al., 2015) adding that companies follow composite strategy, which the main is internal cost reduction, which allows gaining competitive advantage. In this masterwork the main to analyze how innovations, technologies, and strategies affect organizational performance as quality, delivery time and what influence optimization of production and those processes.

From the EDI side, Jun and Cai (2003) analyzed the cost and benefits issues that time company can expect. From the implementation, this system requires additional hardware, software to extend communication links between the partners and extra financial expenses for the system itself. Authors mentioning, that for small companies such investments could be harder and more visible than for the bigger companies from the cost side. EDI as a system requires a high volume of transactions and for the small firms cannot easily gain economies of scale that can be easily seen from the beneficial part. But everything depends on organizational performance and role. There is always a risk to invest assets on IT systems because it can change the way and communication tools between the organizations and relations. Choon and et al. (2010) adding an example that if the supplier is investing in new technologies, which like EDI reduce transaction costs and improve the information process, the buyer can ask to lower the service costs. In other words its assets and cost coordination between the partner's alignments which in the process can achieve the reduction of transportation costs. Collaboration and creation of relationships is the way to reduce no value-added activities and can be eliminated from the supplier process.

From the innovation side in the manufacturing company can be visible in the newest technologies, equipment, robotization process or innovative systems implementation. It is so many different ways to foster organizational performance, just need to invest time, resources and willingness to make changes. Sometimes an organization just needs to make implement something new, to reach better achievements. That something can be EDI or RFID systems. Zelbst and et al. (2012) giving an example from Vijayaraman and Osyk's (2006) study with proves, that the utilization of the RFID system can improve effectiveness in infrastructure. Investment in technologies and the systems and the integration in manual work it is a process to exchange availability to a quicker reaction to changes. Availability to react quicker, ensure better customer service, communication, information flow and reduce operational time. The true evidence can be visible in delivery time, speed, performance, and final rate. Innovations and the cost are working leg by the leg in the company. If the organization is able to invest more on the newest technologies it is getting a competitive advantage against other competitors.

2.3 Organizational performance

2.3.1 Quality

In the previous chapters, I was analyzing separately various systems and tools: mobile devices and equipment, digital planning systems, automatization, robotization, real-time management systems, and logistics chain optimization. These systems and tools can be implemented in manufacturing organizations to improve functional performance, but it all depends on the assets, size, and willingness of changes. Companies are doing changes, because they seek to improve organizational performance in various sectors, arias, such as: in quality, delivery, company flexibility, costs, and innovations.

Considering word quality, it is more general, because the quality we can describe for many things as – service, production, organizational, performance. I can say it has many names and structures. In the manufacturing organization, all systems are connected to each other to create the final outcome – product. Authors (Zelbst and et al., 2012) pointing that effectiveness can be defined as the ability to satisfy customers needs. In the (13 figure) I categorized the possible customers, client's needs for the production.

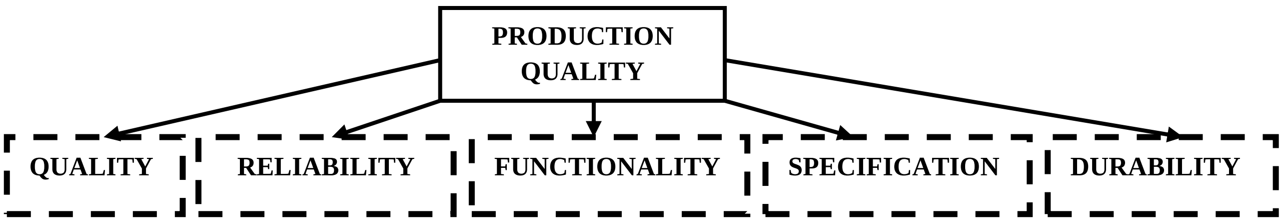

Figure 13. Master work analyze according to the quality (made by author)

In my masterwork, my goal is to analyze different manufacturing systems that influence achievements performance. The first of them is production quality. According to the (13 fig.) we can see different types that are included in the production analyze. Product quality can be described from the government researches and the restriction, how and what should be a specific category to call it an as bad, good and excellent quality product. Also, it can be gained with the brand name and customer comments, response after the usage. The second step is reliability, so for example, it is safe to use this product, all the given instructions are clear, and does this product will work as it was described in the product info pack. To measure reliability, it is the only way to do it quantitative way to check more products that one in different fields. Third step – from the functional side. How this product can be used, just in one function or in more. To describe functionality I can use words like flexibility, weight, how to use, shape, size, design, model. All these elements create a functional side. Forth section – specification is about what is inside the product, what is the main requirements, describing characteristics and allows to make easier product acceptance in different markets in the manufacturing and buying process. Fifth – durability – how long this product can be used, guarantee sheets provided for the customer.

In this research, the main task is to analyze different manufacturing sectors, which have or implemented various systems or tools and how it affected the organizational achievements. From the quality side, I have 5 elements and in the research part, I will analyze how it is the result compared with the competitor, what is the main difference.

2.3.2 Delivery

One of the manufacture processes is delivery. The main issue is the time and the quality of how this process was accomplished. The main elements are vehicles, management, communication, and transportation speed. The main task is to create delivery faster and easier and need to think about the possible solutions as the creation of interlink between similar processes, which can share information in the supply chain. Delivery time depends on the inside system work, as information flow, timing, and management. As authors Powell analyzing, there are several methods to improve different manufacturing aspects to increase capabilities, but it all depends on the assets and flexibility.

From the delivery side, manufacture companies that can manufacture products quicker and have a possibility even to keep the product as a storage position has a bigger chance to deliver and provide faster service than other companies. Each order can have a number of items and about all functional side, such as product, its quantity, and cost and can be reflected in order composition (Chan F. 2005, - pp 163-197).

The main analyzing aspects in the delivery process are quality of the delivery of all product were delivered correctly, without any mistakes. Does it fitted in the time and planned schedule with ought any damages. The main importance is in the timing and possibility to be flexible delivering order. As Jardini and et al. (2015) adding the delivery process importance is to do everything in the right time and in the right place. The new strategy is implementing to make more frequent deliveries in specific deadlines and to make a faster invoice and money flow.

2.3.3 Flexibility

Manufacture entertainment to work properly, need to look at the environmental changes and the demand for production. One of the positive abilities is to have a chance to reduce or increase the quantity of production. From the other side, the manufacturing company is a great advantage and the possibility to provide a special service or a wider range of products to the customer. But comparing with the competitors, it is really important how long it will take to release new products. It might be even too late and the company could get out of the market. In my research, flexibility going together with the production and the main analyzing aspect showed in the (14 figure).

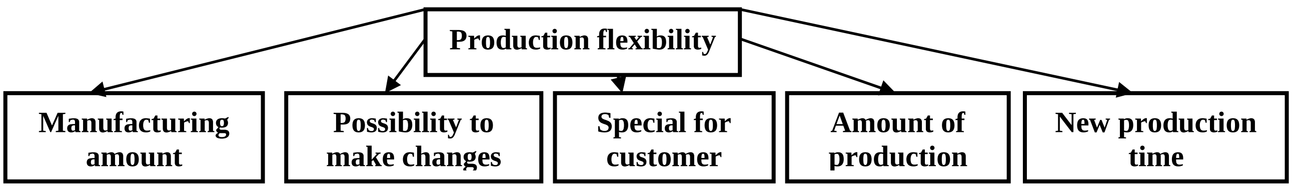

Figure 14. Flexibility importance in production and delivery (made by author)

To make the manufacturing site more productive, we need to think about how to react to the customer order changes and how to make it more flexible. From the beginning to analyze (14 pic.) one of the main aspects is the production volume o have the ability to maximize or reduce the amount. Then the second bonding is with the delivery process when we need to react to the changed delivery schedule. Sometimes to reach the customer is the best way to produce products especially for him or his company. Products usually then are unique and made according to the customer instructions. Manufacturing companies if they have enough assets they prefer to produce a wide range of products because then it is a bigger possibility to reach a wider customer circle and become well known in the market. The market and the need are fast-changing and if the company wants to be competitive, many times companies need to release new production lines faster than competitors. That's why time is really important about the new production.

2.3.4 Cost

Any company before doing any changes in the internal system calculates the possible cost and if it will be useful and will increase profit or service quality. From the cost side is thinking about: product manufacture, product added value and stock turnover. From the innovation side – how fast they can present a new service to the market, how many products should be manufactured and how innovative it should be.

Manufacturing companies inside cost structure can be calculated in various ways, for example, production quality results incompetence with the product price and how many products were sold. From the manufacturing side, the main important cost showed in (15 figure). the monetary results usually count as a profit.

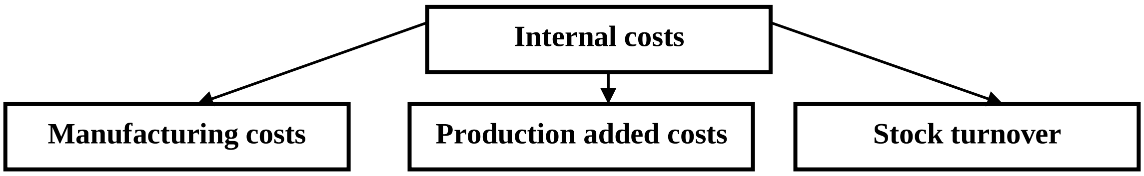

Figure 15. Cost structure in manufacturing entertainment (made by author)

Every entire inside manufacturing process has its own cost structure and it can be counted on every step. To minimize organizational costs, companies are using counting production, materials, time resources to be prepared. Planning with the control strategy helps to avoid the added cost in the manufacturing process because then it is a higher possibility to react to the changes and errors in the right moment. About stock turnover, companies implementing lean planning model which helps to divide manufacturing arias and use as less as possible materials and time management to make all processes faster. Many times companies have more stocks in the warehouse, because than they can use it in the right moment and not waste the time for the waiting.

To summarize, the cost structure is the final outcome how the manufacturing company was working from the beginning, what materials were used, what quality were created, how many extra resources needed to add and how it was working together with the time management. Stock turnover is the way to be prepared for the extra circumstances if it is needed and if there are any changes in the planning, delivery process. Many times money it is investing in innovations because then companies can reach better final outcomes and become more competitive in the market.

2.3.5 Innovations

In this master research as I analyzed before, one of the questions is how 4.0 industry revolution will influence existing business and what innovations are necessary to implement to stay in the market and be competitive. Also, it might be a possibility to come in the market and become known. Innovations can be seen in different ways, in technology, systems, business models or even in the people behavior, thinking. One of the companies want to implement innovations in the business, others decline it as an unnecessary thing. To make a company implement anything new or different that it is existing in the company environment, need to invest money, time, resources and knowledge’s to make it suitable. To compare business and companies innovative level it is the best way to compare with other competitors.

In manufacturing, entertainment is really important 3 factors: how fast company can relic new product in the market, how much time it took, how many different product companies can create and how these products are innovative. According to it, it is really important how a company can compete in the market with its competitors.

In organizational performance chapter all 5 elements as innovations, costs, flexibility, delivery, quality is really important because all of them are connected. All these elements have their own roles. From the innovation side, it is coming possibilities to try something new and reach better results. Before implementing anything new, companies need to do researches and check if it would be suitable in their companies. As it was analyzed previously in (12 pic.), innovations going together with the cost structure. All the changes might bring positive or negative results, it all depends on the organizational performance. Flexibility can be compared together with the delivery process many times because time management is one of the most important aspects of this case. In the delivery process it is important to react to the changes, schedule and satisfy customer’s needs. Flexibility in production management is the way to ensure smooth production planning and after the delivery process. If all 5 elements work correctly in the organization than the quality can be ensured in the end. In other words, if the company wants to be competitive in the market, all manufacturing processes should work as one wheel, smoothly together. But it is just theoretical analyze, in my master research in the second chapter will be analyzed the real systems, tools effect to activities performed in the organization.

3. DIGITAL MANUFACTURING INDUSTRIES EMPYRICAL RESEARCH METHODOLOGY

Technologies are moving in front by providing new, easier possibilities to implement in various business sectors. "Among the manufacturing" entrainments are becoming more famous to adopt automatization is a process. These systems allow making inside manufacturing processes faster. But before implementing any systems or technologies, we need to do research about the possible benefits for the company. From the previous author's researches, it is visual that not all systems can influence positive results, because of the functional abilities.

3.1 Research methodology

The main topic of this research is to analyze how depended variables influence independent variables and what could be done to create even better results. The main purpose of the research methodology to analyze the created conceptual model which is specified in (2 pic.) and answer the research question. In the first chapter is analyzing how 4.0 industry revolution is related to the research problem, do the changes influence positive or negative results in the manufacturing industries. In the second part, the literature review created a framework about separately technologies and systems which can be implemented in manufacturing processes. According to it created research hypothesis – does separately technologies and systems can create positive results in production quality. I also analyzed different authors' researches and opinions about what results can be expected. In this research, the part will be revealed how the data was collected.

The created conceptual model which is showed in the second picture has 2 columns. One of them shows dependent variables, as mobile devices, digital documentation, ERP and MES systems, and EDI and RFID, which can be used or installed in the manufacturing work. The second, independent variables: quality, delivery, flexibility, costs, innovations. One of the research questions is how separately systems are influencing manufacturing performance. But the main seek to analyze and find out what system or tool can influence the best independent performance in the final result. In other words, in this research, it will be visual results among variables.

3.2 Sampling and information gathering

Made questionnaire data were collected as part of the European manufacturing survey (EMS) in 2018. EMS is an international network of research institutions. A questionnaire was standardized to collect data about manufacturing entertainments. The first version of the questionnaire was prepared in English and translated in native language – Lithuanian.

The data was collected on individual manufacturing sites, because each business site unit may exhibit different performance capabilities in different sectors (Boyer and Lewis, 2002; Schroeder et al., 2011). Each country is accepting and implementing the newest technologies differently. Due to minimize countries differences effect, with this purpose of changes the data collection was made in Lithuania and other countries. The relative importance of the Manufacturing sector (NACE sector C) is relatively high in Lithuania constituting 26 % within the non-financial business economy's value-added, as it was already checked in 2015 (Eurostat, 2018). From the data researches, the manufacturing sector is well integrated into an international economy where 80 % of all manufacturing output is exported (Eurostat, 2018).

The sampling frame consists of 6122 manufacturing sites covering all sub-sectors of manufacturing and covers the population of manufacturing sites in the country. The respondents were technical managers or production managers in manufacturing sites with more than 200 employees and general managers, technical managers, production managers in manufacturing sites with less than 200 employees.

It was used as a telephone survey to collect the data because it is the fastest way to collect information. The stratified random sampling procedure was used. Strata were defined in terms of four regions of the country and four size classes of organizations (20-49, 50-99, 100-249 employees). In total it was 932 manufacturing sites contacted. The effective sample is 200 manufacturing sites which constitute a 21.5 % response rate.

3.3 Measures

To analyze the questionnaire part about independent variables as quality, flexibility, delivery, costs, and innovation measuring influence to the competitive performance, it was chosen to use Libert (CPA) question method with 5 marking possibilities. From 1 –much worse, 2 – worse, 3 –little like, 4- better, 5 – much better. To measure the results was used SPSS, results are in 8 table:

Table 8. Component matrix for independent variables.

Pattern Matrix[a]					
	Component				
	1	2	3	4	5
Product features	0.944				
Product durability	0.941				
Product overall quality performance	0.923				
Product conformance	0.920				
Product reliability	0.852				
Manufacturing overhead cost		0.974			
Unit cost		0.930			
Inventory turnover		0.826			
Ability to adjust production volumes			0.943		
Ability to respond to changes in delivery requirements			0.906		
Ability to produce a range of products			0.858		
Speed on new product introduction into the plant			0.857		
Ability to customize products			0.815		
Delivery dependability				-0.990	
Delivery quality				-0.914	
Delivery accuracy				-0.882	
Delivery availability				-0.845	
Delivery speed				-0.834	
Number of new products introduced each year					-0.969
Lead time to introduce new products					-0.955
Product innovative level					-0.939

8 table is divided into 5 types of categories, starting from quality, costs, flexibility, delivery, and innovations. With these, all elements were done factor analysis to check if there are any similarities between the questions. As we can see, it is still existing 5 categories. The highest importance has product features -0.944, lowest – product reliability – 0.852. From the cost structure, we have a higher number – manufacturing overall costs – 0.974, it is the highest number comparing with all table results. 0.815 we have resulted from the ability to customize products. From table 2 graphs: delivery and flexibility are with negative results. According to the results it was created 5 separate factors, which we can see in 9th. table.

Table 9. Assesement of the realiability of the questionnaire (made by author)

Constructs	**Qustions**	**Construct reliability (Cronbach alpha)**		**Author/source**
Performance dimensios		**Questionaire measures**	**According to the author**	
Quality	Product overall quality performance	**0.962**	**0.949**	Roger and et al. (2011)
	Product reliability			
	Product features			
	Product conformance			
	Product durability			
Flexibility	Ability to adjust production volumes	**0.942**	**0.905**	Roger and et al. (2011)
	Ability to respond to changes in delivery requirements			
	Ability to customize products			
	Ability to produce a range of products			
	Speed on new product introduction into the plant			
Delivery	Delivery accuracy	**0.959**	**0.923**	Roger and et al. (2011)
	Delivery dependability			
	Delivery quality			
	Delivery availability			
	Delivery speed			
Cost	Unit cost	**0.906**	**0.906**	Roger and et al. (2011)
	Manufacturing overhead cost			
	Inventory turnover			
Innovation	Lead time to introduce new products	**0.968**		
	Number of new products introduced each year			
	Product innovative level			

In the first column of 9 table, it was analyzed Cronbach alpha for separate groups of questions and the answers we can see in the questionnaire measures part. All these questions were in the questionnaire. I compared the questions validation with the author Roger and et al.,(2011), the pink and blue is what the author is offering to use in the questionnaire. We can see the Cronbach alpha results in the last column. The result is similar comparing both columns, just in flexibility part the difference is more visible than in others. 0.942 from all my questions and 0.905 from 3 authors offered questions. The difference between Cronbach alphas is 0.037.

3.4 Data analysis methods

To make research was chosen – empirical method, questionnaire. For dependent variables as mobile devices, digital documentation, real-time manufacturing control system were questions: it is operating already in the company and how it is beneficial: low, average, high or second option – the company will implement it from the 2021 year. From 200 companies just 118 already implemented and using digital manufacturing control systems. The second questionnaire block was about the independent variables as production quality, delivery time, flexibility, production costs, and innovation. There were 5 possible range answers to compare it with the competitors: much worse, worse, similar, better, much better.

To summarize received questionnaire data was used Microsoft Excel to make diagrams and for statistical analyze was used the SPSS program. Using the SPSS program was also used methods as:

1. First I did Factor analyze. According to Pukenas (2009) first step correlation separate in the different variables groups, which have similarities. Usually, in factor analyze there are answers from I totally disagree to fully agree. The seek of the factor analysis to make smaller groups of the answers and to show that grouped elements fit in the same scale.

2. Cronbach‘s alpha method is a tool to check how data is reliable. The coefficient can be measured from 0 to 1. To analyze coefficient meanings was used explanations from Gerikiene and Petrauskiene (2009) research:

- Cronbach‘s Alpha < 0.6 scale is low, so not recommended to use
- 0.6 < Cronbach‘s Alpha < 0.7 scale is reliable
- 0.7 < Cronbach‘s Alpha < 1 scare is recommended to use.

From the authors researched, they are mentioning that Cronbach‘s Alpha is dependent on the scale how many numbers of variables was used to check reliability. Authors mentioning that if it will be used more variables, that it is possible that Alpha will be higher and need to evaluate the value of the Alpha coefficient, if it is lower, that the reliability also smaller.

Spearmen correlation. As authors Bilevičienė and Jonušas (2011) describe, spearmen method is non – parametric research to check the connection between separate variables. In my research, it used to check if there is any link between the hypotheses. In the (10 table) we can see how the results can be interpretive:

Table 10. Spearmen correlation according to the link (made by authors: Bilevičienė and Jonušas (2011); Bačinskas and et al.,2001)

Negative coefficient results	Correlation link strenght	Positive coefficient result
0.00	**There is no link**	0.00
-0.19 - -0.01	**Weak link**	0.01 – 0.19
-0.39 - -0.20	**Weak**	0.20 – 0.39
-0.69 - -0.40	**Average**	0.40 – 0.69
-0.89 - -0.70	**Strong**	0.70 – 0.89
-.099 - -0.90	**Very strong**	0.90 – 0.99
-1.00	**Linear line**	1.00

From the authors analyze, signs are also important as (*). If it is just 1*, then the meaning is 0.05 if it is 2 -** - 0.01. But if the final numbers are without any symbols, then the connection between the variable is insignificant and it is not necessary to make more analyses.

The regression method is a mathematical sorting way to show the real influence between the variables. It is the way to see which variables make the most effective to the independent variables and how they connect with each other. Lapinskas (2013) adding that with linear regression help can be seen dependent variable dependence from the independent variable. But in the data, it can be visual when it is in linear dependence and we can mark it as (Y).

Below we can see a linear regression equation which will be used according to authors (Bačinskas, Janilionis, Jokimaitis, 2001):

$Y = \beta 1 + \beta 2x$,

$\beta 1$ in $\beta 2$ – non known parameters, which need to find out

According to Lapinskas (2013), if we found a linear model, we can predict how will chain Y if we will change the independent variable. Using all the above mentioned SPSS program methods in the second chapter, data will be analyzed according to it. The results will show how information is valid and important in our research.

4. RESEARCH FINDINGS

As mentioned previously, this questionnaire was made in an international context (in 15 countries) and then translated into the native language in every participating country and added an extra block of questions. This questionnaire was used in Lithuanian to check and compare manufacturing organizations and automatization level. To collect data it took around 2 months.

4.1 Manufacturing industries demographical analysis

The purpose of this chapter is to provide empirical researches of the manufacturing organizations in Lithuania. In the first part analysis consisted of demographical questions: from which regions we collected information, who were the main respondents, what types of manufacturing industries were participating and how many years they are operating in the market, age groups and how many employees are working in the organizations.

In total it was 205 answers from respondents from various industries. Data were analyzed by using SPSS and Excel programs, starting from checking reliable analysis, then factor and Spearman correlations to check if there are any similarities between the dependent variables (systems, tools) and in the second option – independent variables (activities performances).

With the first demographical question, the main seek was to analyze from which region data was collected. Lithuania was diviled in 4 regions: The percentages we can see in (16 figure).

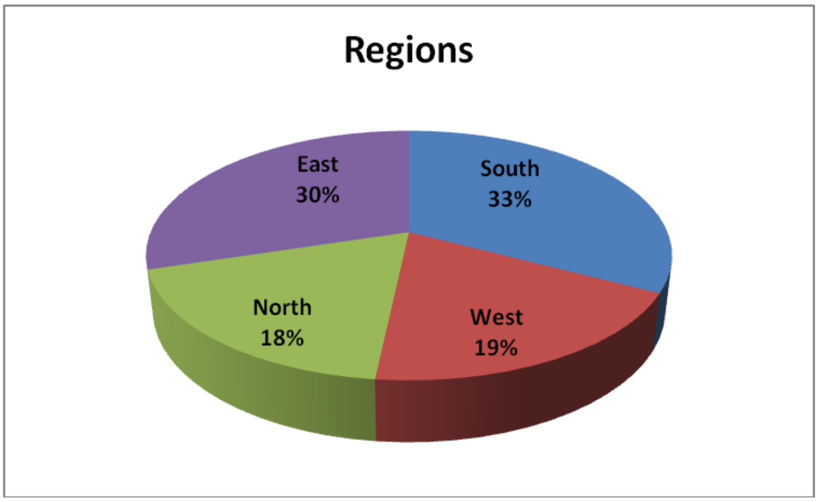

Figure 16. Lithuania divided in 4 smaller regions

The most answers were collected from South – Kaunas, Alytus, Marijampole – in total received 34 % of answers. Second place- East – Utena, Vilnius – 30 %. West – Telsiai, Klaipeda, Taurage, and North –Siauliai, Panevezys – have equally 18 %.

Collect the answers there was used tool – telephone survey and in (17 fig.) we can see who the main respondents were.

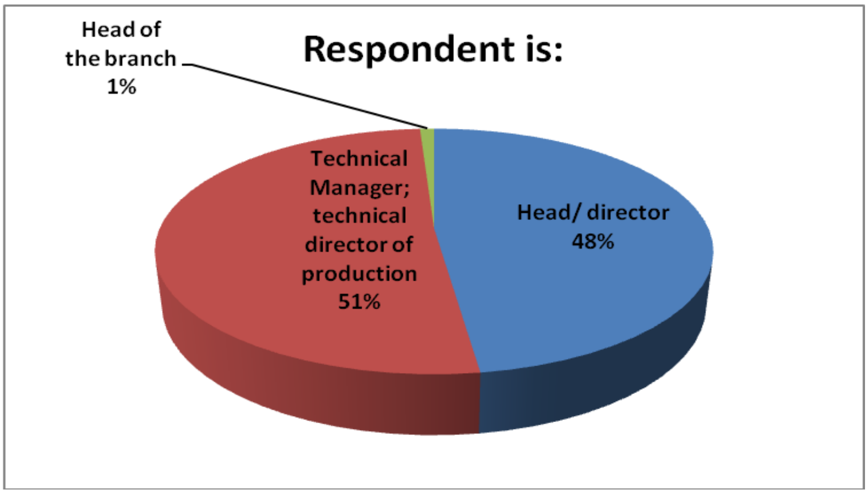

Figure 17. Respondents by the categories (made by author)

To answer questionnaire questions, respondents need to know many factors about the company and have access to the information about the company structure, technical information and to have an idea about company mission, vision, competitive performance. As we can see from the 17 figure, there were 3 categories: Head Director, a Technical Manager and Head of Branches who answered the questionnaire. The first 2 categories percentage result in almost the same, just in the third category (Grey) have 1 percent. To summarize the organization age of the organization, we can see in (18 figure)

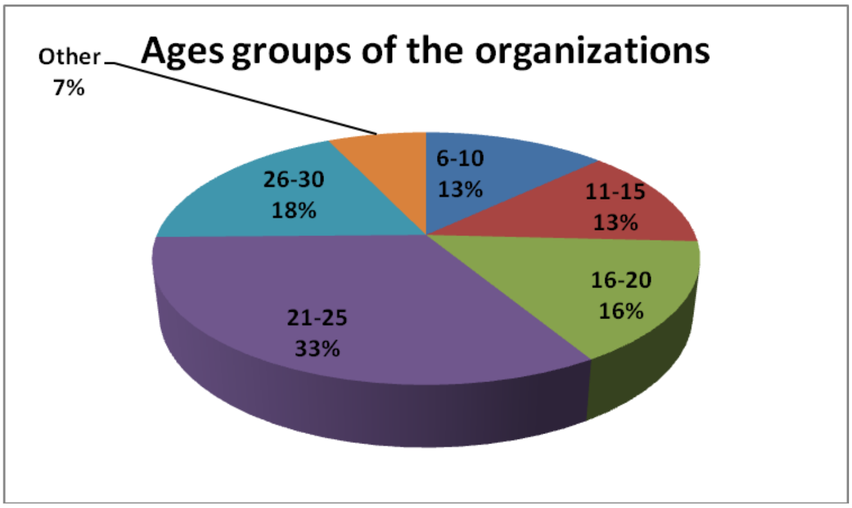

Figure 18. Age groups (%) of analyzing organizations

In this polar graph, companies by the ages were divided into 6 categories from 6 till 30. In the other, it is included data from 1 till 5 and from 31 and more. From the graph, we can see that the highest % number is from 21 to 25 years and second from 26 till 30.

The number of employees is an important question because I'm thinking about what could be the changes with the automatization. Even it is considering the point, how many people are working and how many are needed in different manufacturing fields. Times are changing and the number of employees in different year period would be one of the measurement tools to check, how the automatization affect the quality, workers number and the final process time. To repeat again in the questionnaire in total I had 205 respondents. To make it more visual, I created a chart, which we can see in (19 figure.)

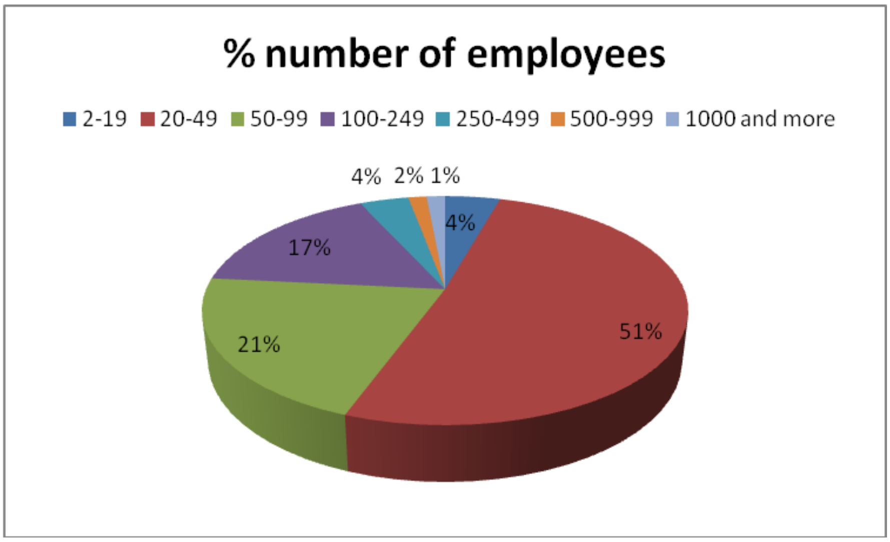

Figure 19. The % of employees working in manufacturing industies

The main reason why I decided to create a pie chart in (19 figure) is because it is more visual to show a percentage view about the number of employees working in the manufacturing industry. The main needed number in various industries is around 20-49 and it is talking about – 51% of the chart. The second category with 21% - 50- 99 working people and the third – 17% from 100 to 249 employees.

One of the question in my work is to analyze how manufacturing industries are implementing automatization and how they affect the number of employees. In the 20 figure, we can see how many people are working in each sector.

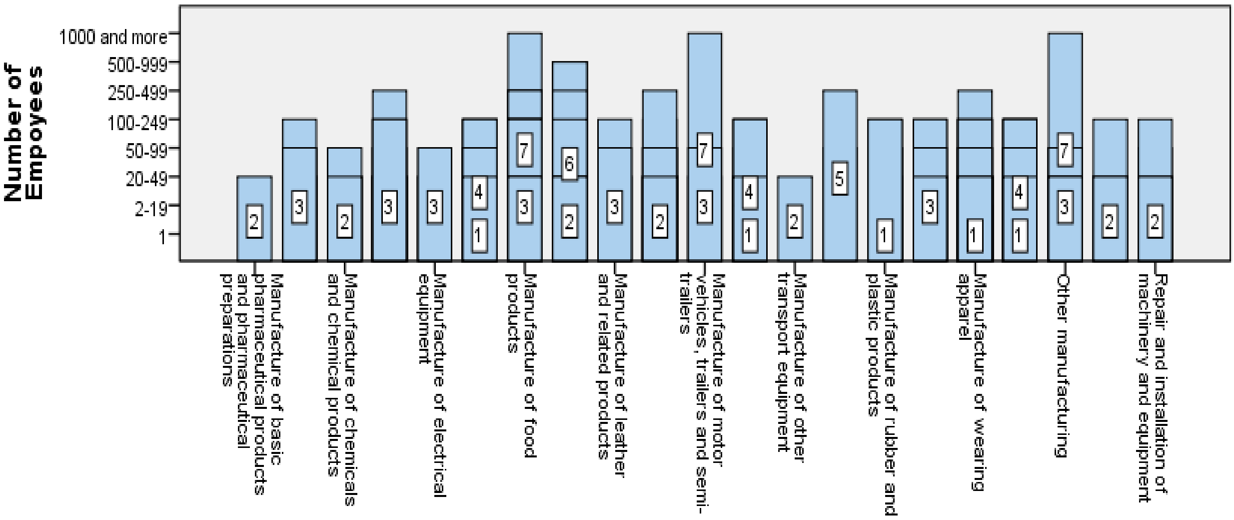

Figure 20. The number of employees

The number of employees was categorized in 8 possibilities, from 1 till 1000 and more. There we, not industries which could fit in the first and second categories till 19 workers. Category 20-49 it was in total 13 industries. From this point, the number of employees was rising. The average number of employees in manufacturing company is100-249, as we can see from the (20 figure).1000 employees and more have 3 industries: food product, motor vehicles, and other manufacturing entertainments (as respondents specified in smaller categories).

With the second mixed demographical question was seeking to answer what type of manufacturing industries were participating in the questionnaire and how many years these companies are operating in the market. It was used as a combined question. The result we can see in (21 figure):

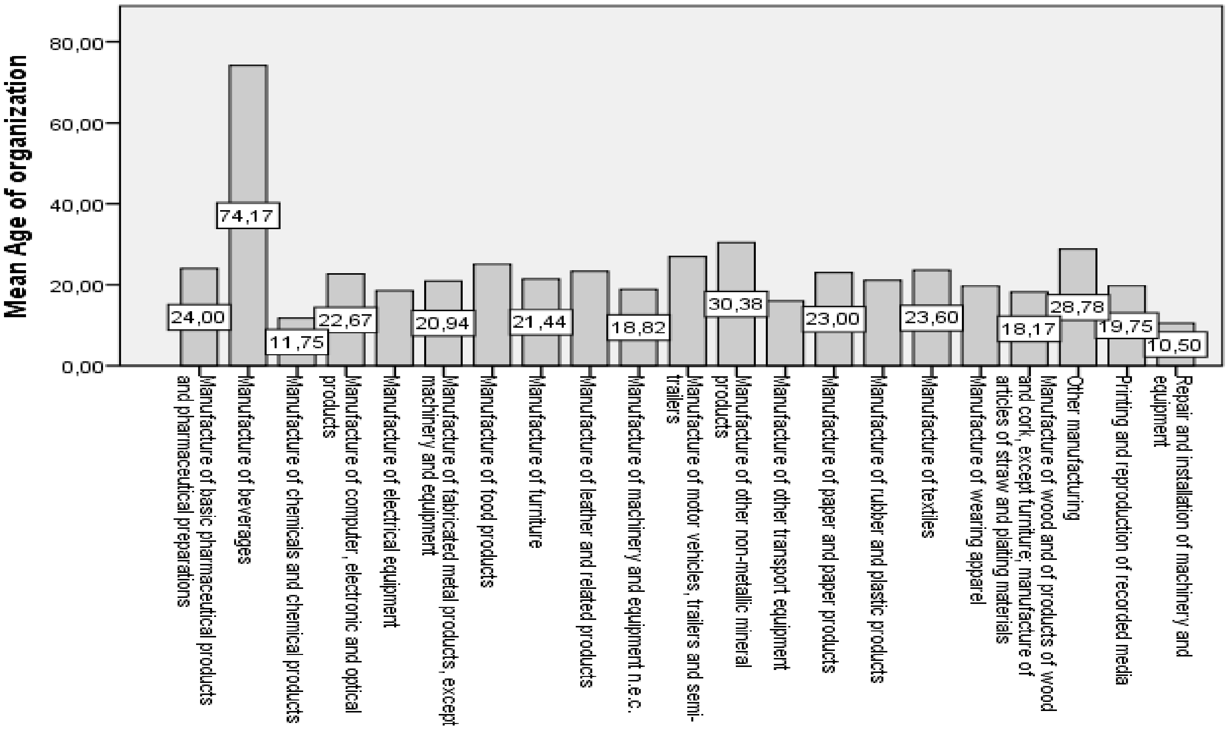

Figure 21. Manufacturing industrines

This histogram was made from 205 respondent's answers. In total it was counted 21 different industries: pharmaceutical, beverage, chemicals, electronics, furniture, vehicles, and others, as we can see in (21 figure.). We can see in this questionnaire answered really wide spectrum industries. The average year for all industries would be around 20-25 years. From the picture the 2 youngest companies which are operating around 11 years – repair installation and chemicals products. The oldest – manufacturer of beverage working for around 74 years. All these companies are in the market for a long time and have their own valuable experiences.

4.2 Overview of digital manufacturing technologies and performace dimensions

In this chapter, I will analyze separately technologies, systems and independent variables. In the first part, I used the SPSS to analyze and gather answers to see how respondents separated systems usability in the practice. In other words, what are the true potential systems, devices usability in the manufacturing companies. Then I separated means and Std. deviations for the dependent and independent variables. After, the second step was to check the connection between the variables.

Digital manufacturing technologies

I will start to analyze the systems and devices. In my questionnaire I have analyzed 6 types of systems and to make it shorter I will use just the system name:

• Mobile/wireless devices for programming and control facilities - mobile/wireless devices

• Digital solutions to provide drawings and work schedules or work instructions directly on the shop floor – digital documents

• Software for production planning and scheduling – ERP

• Exchange of production, process data with suppliers/ customers – EDI

• Near real-time production control system – MES

• System for automation and management of internal logistics -RFID

In the first questionnaire part about the systems, respondents could mark if it is already operating in the manufacturing site or not and if it is planning to be from 2021 years. The second question was to mark categories if this system is operating in the site to measure capabilities and affection of the system: Low, Medium, and High.

From the measure of 3 categories, I decided to use frequency results and the valid percentage to make it visual as a linear bar. I created 6 figures (from 22 fig. till 27 fig.) to analyze separately digital technologies. On the top its written technology name. Then in the linear graph itself, it is visible frequency number of respondent's results of the evaluation of digital manufacturing technologies. Then - valid percentage (which is written in upper linear bar and the marking is with -% sign). The meaning of it is to see what is the % score of respondents answers, which is made of frequency number.

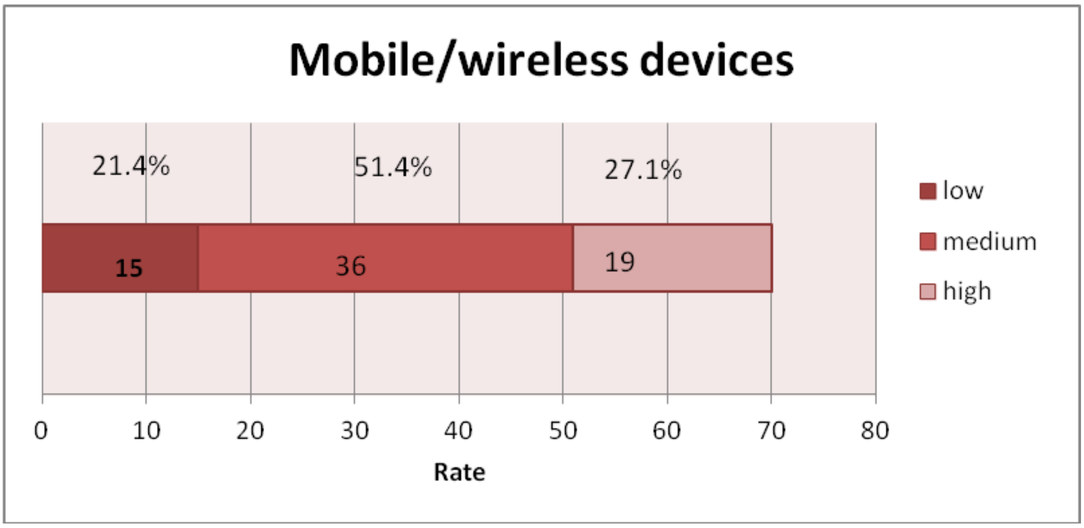

Figure 22. Mobile devices analyze

I will start to analyze from the digital manufacturing control system as mobile/wireless devices (22 figure). I received just 70 valid answers (135 respondents mentioned that this technology is not operating in the companies). There were 3 options to measure technology satisfaction and usability. In the graph, the numbers mean frequency results: 15 respondents saying it is giving low value, 36 –medium and 19 – high. In the valid percent graph, we can say that more than 50 % of respondents think it is giving medium value to the manufacturing operational site.

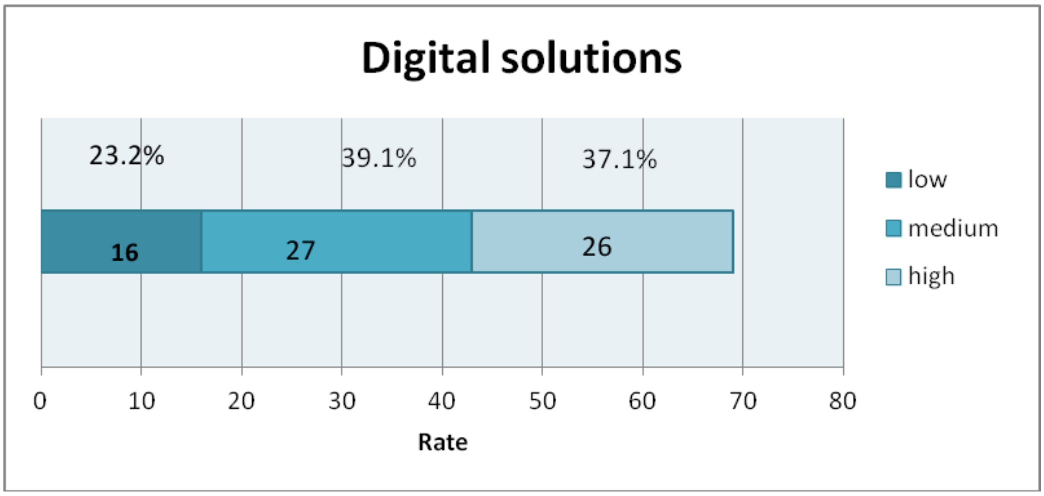

Figure 23. Digital solutions/documents analyze

In the (23 figure.) we can already see some differences than the previous graph. This time I had 69 valid answers. 16 respondents mentioning that digital solutions still providing low efficiency in the manufacturing site, but this time medium and high the number of answers is almost the same. Medium – 27, high – 26. The validation of percentage is the highest in the medium option – 39.1%. Not fully, but almost 80% of respondents, marked that digital solutions/ documentation has potential technology usability, which can be described as average or higher.

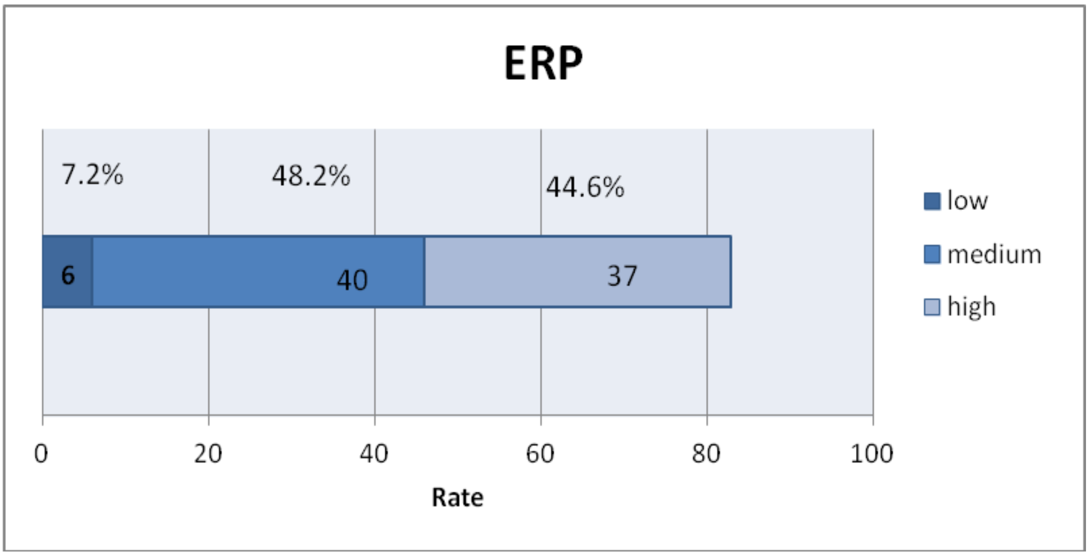

Figure 24. ERP system analyze

Comparing to the previous 2 pictures, I have the highest number of respondents - 83, where the ERP system is used. Form the data we can see just 6 respondents marked that production planning and scheduling program providing low efficiency. In the medium sector, we have -40 markings and in high – 37. To look again an invalid percentage, a similar result is in medium and high as systems potential usage, but still, the medium answer has a higher percentage – 48.2 %. ERP system described as low efficiency is just – 7.2%. I can say its positive result.

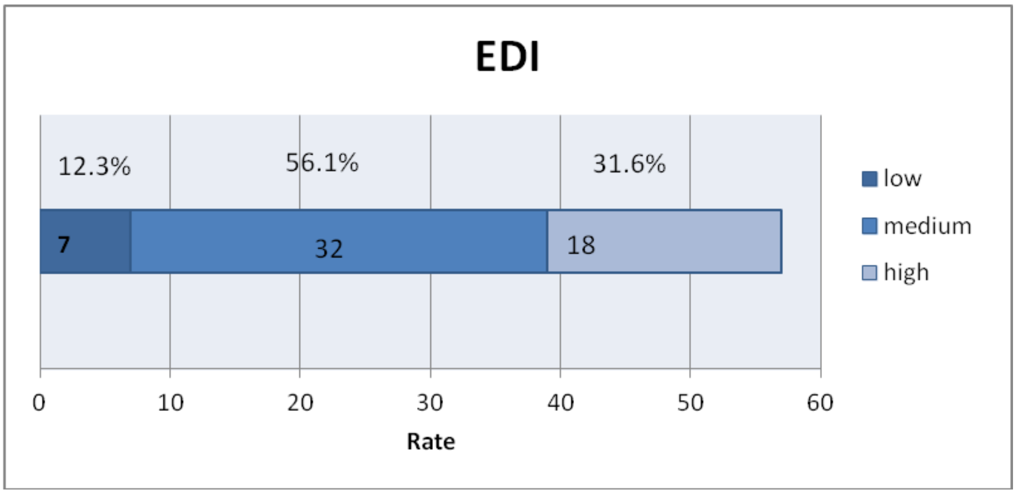

Figure 25. EDI system analyze

The number of system usability is getting lower. This time I have just 57 answers. Respondent marked that EDI as a system is providing more medium technical usability and from percentage having 56.1%. Described as low in frequency graph I have just 7, and high -18 answers. To summarize (25 figure) medium + high, the result would be 87.7%, which is giving a positive results about the system usability. Just 12.3% of respondents marked as low potential. Till now on, from all respondents answer about the systems the highest category is medium. Let's see if it does any changes in other tables. One more fact to add, this system conceptual model is changing to create a better connection with the suppliers and the customers and instead of creating a closed system, the goal of a new business model to make it more open, than the information flow will be increased.

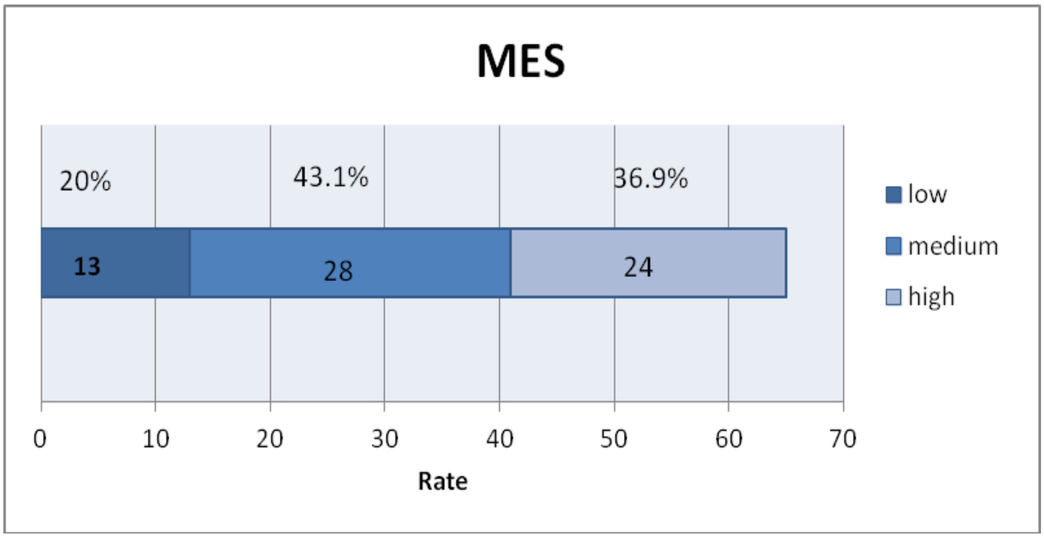

Figure 26. MES system analyze

About the MES system in the practice I have 65 answers, from them - 13 providing that as a system it has a low potential, other respondents have a different opinion. The number in the medium sector is 28 and in high – 24. To describe results in % in the valid figure graph, the highest number is in the medium section, but the difference between high and medium is small, just 6.2%. To sum-up 1/5 of the respondents think, this MES real-time production system has a low potential, but 80 % see the potential average or higher.

In the last picture, I will analyze the internal logistics management system and then I will compare all systems results. Lets's see if it is any changes in the last results.

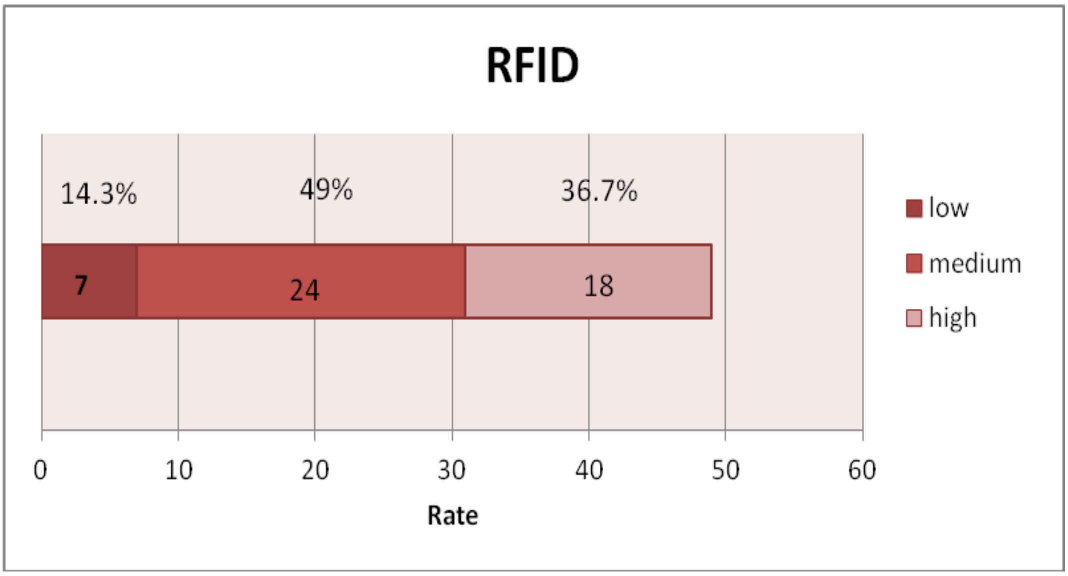

Figure 27. RFID system analyze

About the RFID, the number of respondents is the lowest of all pictures, just 49. The results divided the same as in other tables, the lowest answers are in low category – 7, the medium has the highest number from the table – 24 and high have 18 answers, 6 less than medium. I can say, even if it is fewer respondents, but still, the results are similar to the other tables. Almost 50% is in the middle category. If to sum up medium and high, the % result would be 85.7% and just 14.3% of respondents think that the system is not that useful.

From all the histograms which were showed in the 22-27 pictures results, I can see that the most answers are in the middle category, none of the answers were higher in the low potential category. Many answers in high were so close to being leading as we saw in MES, ERP, and digital solutions tables. To summarize from the table results can be - that the systems are still not perfect in the manufacturing entertainments and it still needed to have improvements, but it also can be added that not so many respondents from 7.2% till 23.2% marked that these systems have low potential.

The really visible result is missing the place – the number of missing in many digital technologies results is 3 times bigger than the total result part of respondents. That's the sign, that many of the companies are not using digital technologies in the manufacturing sites. From the gathered respondent's results, I used the SPSS program to separate the mean. I will analyze results in the histogram. I also used the value of std. deviation. Std. deviation usually explained as data value deviation and how far, different it is from the mean. The highest number I have from data is- 0.772 of digital solutions. That's meaning why the answers were separated (as we saw in 23 figure). The similar, high std. I have in MES -0.741. The lowest is in ERP – 0.619 std., and this section has a more consistent score. In ERP section there were fewer answers that the program has a low potential of usability. Visual results of mean we can see in (28 figure.):

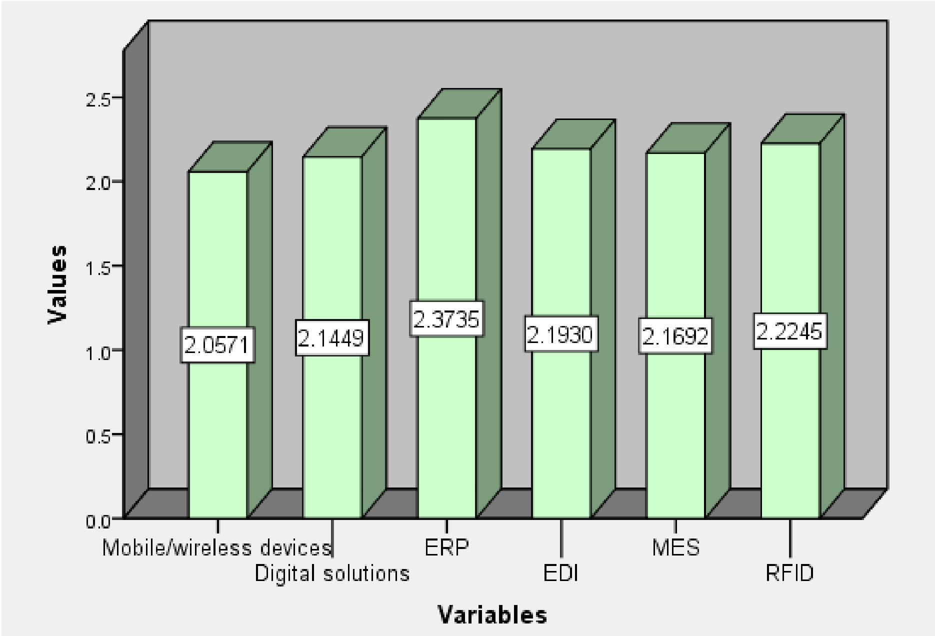

Figure 28. Mean statistic value for the Digital manufacturing technologies

In the (28 pic.) we can see how technical systems and devices are divided by the size in the histogram. In the previous (22 - 27 figure) I was analyzing frequency graphs and valid percentage how the respondents evaluated systems. In this histogram, we can see the value of the means. Also should point out that in the questionnaire were possible 3 options, from low, medium and high, so in the numeric category it would be from 1 till 3. The means that is closer to the 3, has higher potential usability. Mobile/wireless devices have the lowest - 2.05 number from the chart.

This result might be because of the technical movement and innovations, people need to get used to the new ways of work. The highest – 2.37 ERP system, comparing the result with the author's analysis, this system is used for many years for manufacturing production planning. Not so far with the result is RFID, logistic system – 2.22 mean. The similar meanings are between 3 technologies – Digital solutions, MES and EDI. In the second chapter, I will analyze the activities performances.

Performance analysis - means of performance dimensions

The company's performance depends on many factors: timing, control, task combination, the reaction in the right moment, problem-solving, savings and ecs. From the (8th. table) we can see that I made from 21 questions-5 categories of independent variables. In quality included 5 questions, it is about product quality, reliability, functionality, specification, and longevity. Inflexibility part – also 5 questions and it was about the amount of the production, how to make it specific for the customer, how much time needed to release a new product, various amounts of the production. Delivery – 5, accuracy, dependability, availability, speed. Costs – 3, of unit, manufacturing, turnover. Innovations – 3, new product amount per year, innovative level.

In this chapter, the main task is to compare frequencies data with a valid percentage. I'm using this statistic because from the respondent's opinion about the manufacturing process outcomes, I can make predictions about the manufacturing industries situation in the market. The second part will be an analysis of mean and std. deviation, if it is any differences comparing received frequencies and mean meaning.

In the second block of the questionnaire, respondents were comparing their company's achievements to the competitors. They had 5 options, much worse, worse, similar, better, much better. In number position it is from 1 till 5. 1 would be much worse and 5 – much better Using the SPSS program and Excel I made (28 pic.) and I will compare frequencies and the valid percent graphs of performance analysis. Instead of making tables, I combined all data in 1 bar graph. But before I want to point out the valid respondent's answers and how many of them were missing. This we can see in (11 table):

Table 11. Valid and missing number of respondents answers

		Quality	Delivery	Flexibility	Costs	Innovations
N	**Valid**	175	163	149	135	145
	Missing	30	42	56	70	60

In total it is 5 groups of manufacturing performances. The highest valid number I have in the quality section – 175 responses. The most missing is in costs graph – 70 of 205. The main meaning of this table, to have the ability to see how many valid responses I had and how many of them were missing. This might influence data statistics. Before starting analyzing (29 pic.) I would like to describe the meaning of the picture numbers. It is made in the linear bar, horizontal position. There are 5 different analyzing categories. For example, quality line – in the bar it is written respondents frequency results, how they evaluated competitive performance. The meaning of it is to see which ranking is leader. Upper on the bar it is written valid percent which is made from frequency results. From these both data I can see the numbers and how many percentages it would be. To see the collected results, we can in (29 figure). I will start to analyze from 1 – quality.

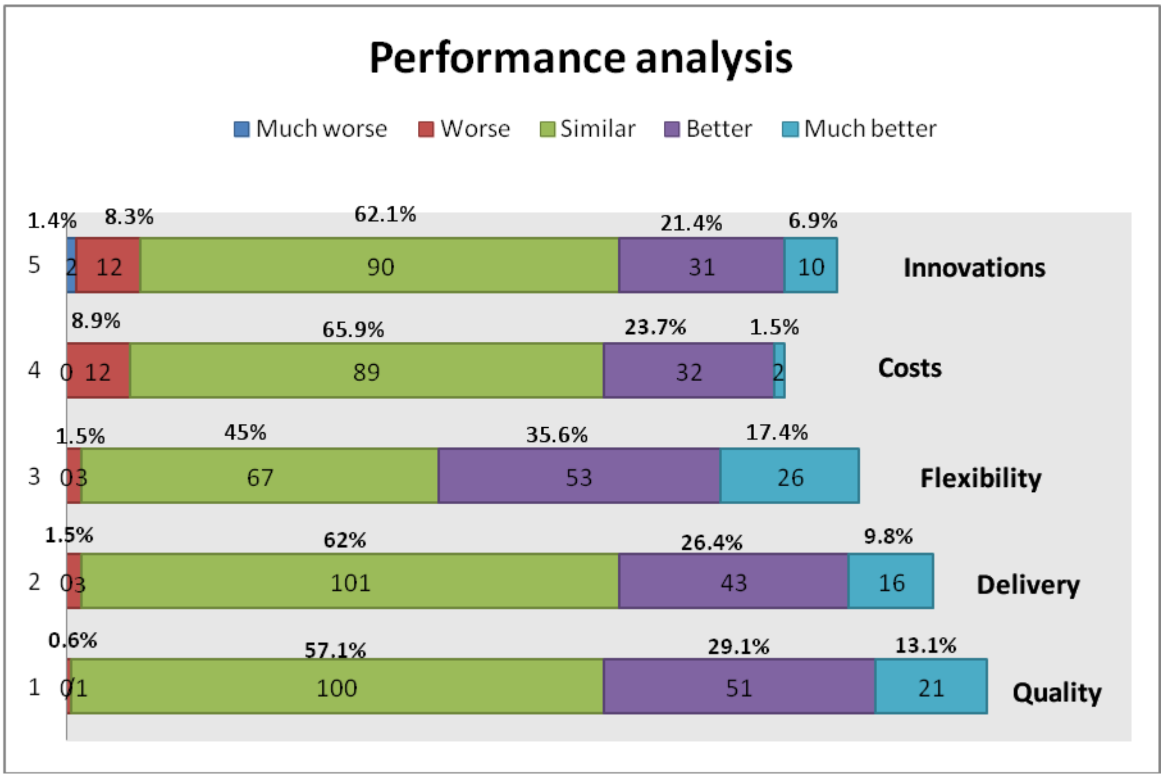

Figure 29. Performance analysis comparison (made by author)

In this (29 figure) we can see the scale from 1 till 5, which is the most visual in the innovations line. In other sectors, there weren't any answers which would be included in first ranking – more worse. Then in the line, it is written categories and frequency number and upper - valid percent. I will start to analyze from a quality, identically as I did before with dependent variables –systems and devices. In the quality column, we can see that valid is 175 respondents answers, 30 are missing. In the first category much worse none of the respondents marked as optional. Worse, I had just 1 marking. The highest is in the category – similar -100 answers which invalid percentage graph would be more than 50% - 57.1%. 51 respondent think that the production is better than competitors, in percentage it is – 29.1% and much better – 21 marking – 13.1%.

In the delivery sector, I have 12 fewer answers that I had in quality. This time it is 163. Line analysis starts from the second graph – worse – 3 respondent's answers. The second section it is almost the same as I had in previous analysis, 101 markings which would be valid 62%. From the delivery part we can see that many organizations think that they can provide a similar delivery service as the competitors. Better – 43 – 26.4% and to create a much better service - can just - 16- 9.8%.

Inflexibility part I have 149 answers. The first two sections it is identical to delivery analysis. The difference we can see in the 3 -4 category. The amount of answers is not so different. In 3 categories – similar 67 answers – valid 45%, 4 better – 53 – 35.6% and much better 17.4%. I can say that around 54% of the companies think that they can provide better than average flexible manufacturing organization than other companies.

From (29 figure) results I can summarise. From the data which I can see, I'm going to conclude that around half of the companies trying to create similar production quality, delivery service, but investing more to create flexible service. Inflexibility part from the frequency results, its visible similarities between the third and fourth ranking. That is mean that companies are investing more to create better service, flexibility in the manufacturing process. To provide much better quality can just – 13.1%, delivery – 9.8% and flexibility – 17.4%.

In the cost line I have 135 respondents' answers. Instead of much worse /similar/ better/ much better worse, in the context, it would be: the company has much bigger costs/ bigger/ similar/ less / much less. None of 135 respondents think that the companies have much bigger costs than competitors. Around 9 percent think the costs of manufacturing are bigger than competitors. 89 marked that‘s a similar situation. 32 respondents- 23.7 % of response rate, a marker that - they have fewer costs and better manufacturing situations. And just 2 persons marked as much fewer costs.

In the innovation line I can see the difference in the beginning. In the first-rate, much worse I have 2 answers. Worse – 12 – 8.3% invalidation. 90 marked that is a similar situation about the product innovative level, which would be 62.1% the biggest number in the graph. Just 41 companies out of 145 can provide better or much better new production release time in the market.

Comparing all 5 variables lines, I can say that companies trying to provide similar or better service in quality or delivery. Investing and competing in flexibility aria about manufacturing production organization and communication, bonding with the customers. Talking about costs many manufacturing industries having similar costs structure, comparing to the competitors, but the main question is how 23.7% of the companies can have fewer costs and 1.5% much less? What these companies are doing to reduce cost structure? My main topic is about innovative and how the companies are accepting it. From the last table, we can see that the innovative level among the companies is similar, which would be 62%. Just 28.3% of the companies are trying to compete between each other and release products quicker and in a more innovative way.

As we saw from the (29 figure) in frequency part all variables are similar, but more visual differences appeared in costs and innovation pictures. Std. the deviation is to show how to vide were the answers from each other. I want to mention that in innovation I had 0.74 results, which means that respondents had a more varied opinion in this section. The second is in flexibility – 0.73. Sometimes it is hard to measure how the company can provide flexible service in the production and manufacturing planning process. The lowest difference is in the cost section, just 0.58, that‘s mean around half of the respondents had a similar opinion. Comparing together mean and std. the highest number is in flexibility part - 3.8 and 0.73, the second is in quality 3.6 and 0.71.

In the (30 figure) I will analyze mean in the histogram, we can see it below:

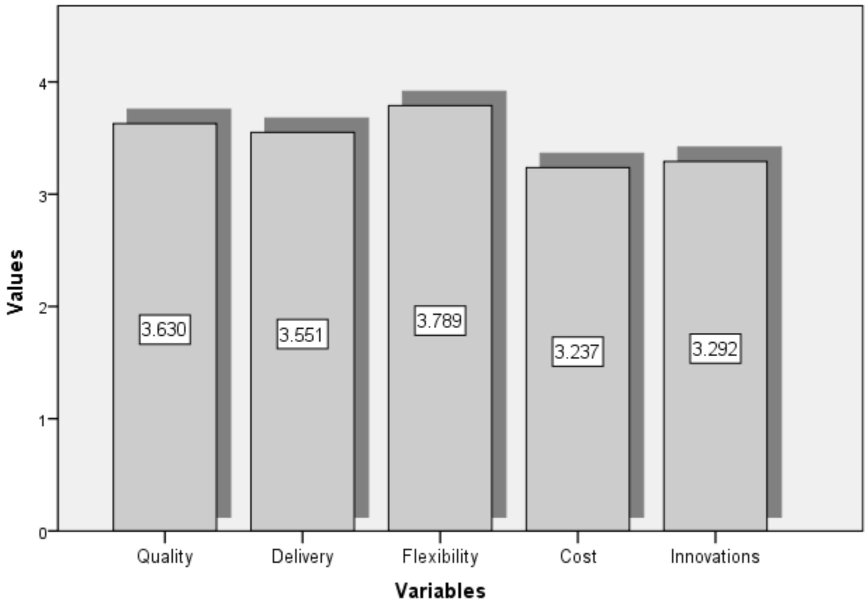

Figure 30. Independent variables mean statistics

I had 5 answers categories from 1 till 5. 2.5 would be a third category – similar, but from the histogram in (30 fig.) I can see that all results are more than 3 rates. The meaning of it is that companies are investing also to be better in the market and compete with the competitors. The highest mean rate is in the flexibility category, around 3.8, the second is in quality -3.6 because to be different and provide better quality products can be a success sign. Companies are trying not just to be similar to the competitors, but also provide better or much better production rates. The lowest means are in the costs and innovation positions. These sections are similar, because of the manufacturing costs they are having and the innovation level they can graph results is similar and the comments which I wrote before, would be the same. Comparing the companies, flexibility and cost structure is in the leading position and companies are trying to improve cost and innovation sectors, but it is in the progress as we saw from the missing section.

4.3 Correlation between digital manufacturing technologies and performance dimensions

In this chapter, I will analyze technologies connection to the technologies, activities performance to the activities performances and technologies connected to the activities performances. The name of the analyzing part is marked bold to separate. I did Spearman Correlation analysis to see the links and connections between the variables and check the strengths of the value. Close connection shows that the variables have an influence on each other performance.

I would like to point out some measure symbols meanings as the significance of the connection. This symbol means (*) – correlation is significant at the 0.05 level. The second one (**) – correlation is significant at the 0.01 level. If there are more symbols that‘s mean that the connection is stronger and important. Also, it is important to mention that if in the tables which are described below near the numbers there is no added any signs, that‘s mean that this number is not significant and it is not necessary to make further investigations. I will start to analyze from DGM:

Correlation between Digital manufacturing technologies

Table 12. Spearman correlation analysis for technologies

		Mobile/ wireless devices	Digital solutions	ERP	EDI	MES	RFID
Mobile/wireless devices	Correlation Coef.	1.000					
Digital solutions	Correlation Coef.	.170	1.000				
ERP	Correlation Coef.	.126	,397*	1.000			
EDI	Correlation Cof.	.261	,482**	.309	1.000		
MES	Correlation Coef.	-.084	.307	,452**	-.019	1.000	
RFID	Correlation Coef.	-.003	.401	,702**	.183	.058	1.000

**Correlation is significant at the 0.01 level
*Correlation is significant at the 0.05 level

The correlation sign determines the level between the variables and connectivity. From the (12 Table) we can see that mobile wireless devices don‘t have any connection with the 5 digital technologies mentioned before. From Digital solutions and documentation side I have 2 correlation results: with ERP, $P<0.05$, $R=0.397$* and a stronger connection with EDI, $P<0.01$, $R=0.482$**. In the practice used digital paperwork can influence faster manufacturing process planning and communication with the suppliers/ customers. ERP system itself has connections with the MES $P<0.01$, $R=0.452$** and RFID, $P<0.01$, $R=0.702$**. Correlation number between RFID and ERP is the strongest in the table. It is showing a high connection between the systems. Also as MES and ERP – product planning and control systems need to cooperate with each other to reach the positive results in the manufacturing process. From the 12th. Table I made (31 figure) – visible connection matrix, which we can see below:

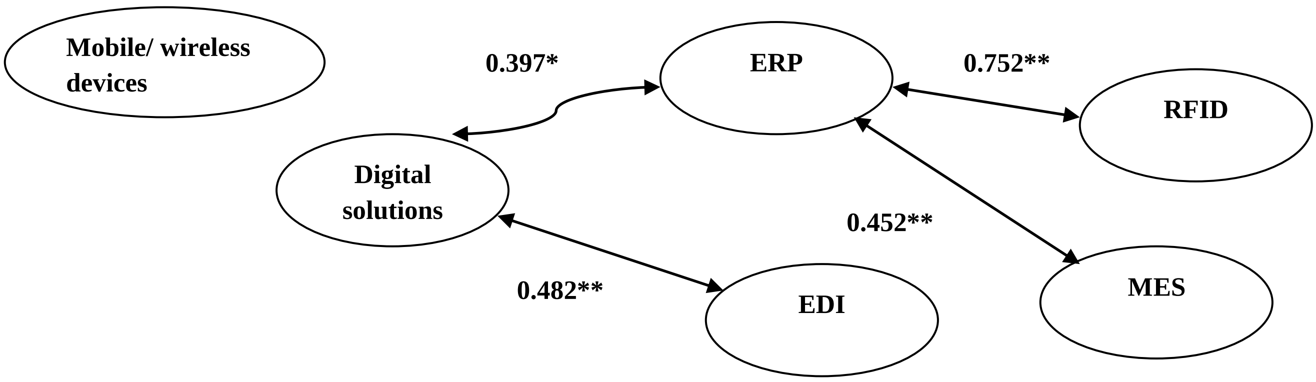

Figure 31. Correlation links between the technologies

From the visual 31 figure I can add that the most connections have ERP system, in total with the 3 technologies. From the (11 table) we can number then I described the connection between the technologies and possible influence, and in this picture, I made it visual. The main goal was to show the connection and system connectivity with each other. With the SPSS system I made Pattern matrix to check if the systems are cooperating with each other and the result I got was:

ERP+MES+RFID= 0.697 Cronbach alpha and Digital solutions +EDI=0.613 Cronbach alpha and Mobile/wireless devices didn't fit in any category and separate alpha was – 0.679. The same results we can see in (30 figure), the technology connectivity. The second step, I will check the connections between the manufacturing outcomes: quality, delivery, flexibility, costs, and innovations.

Correlation between performance dimensions

Table 13. Spearman correlation analysis for performance variables

		Quality	Delivery	Flexibility	Costs	Innovations
Quality	Correlation Coef.	1.000				
Delivery	Correlation Coef.	,507**	1.000			
Flexibility	Correlation Coef.	,407**	,443**	1.000		
Costs	Correlation Coef.	,304**	,343**	,266**	1.000	
Innovations	Correlation Coef.	,400**	,428**	,515**	,455**	1.000

**Correlation is significant at the 0.01 level

From the (13 table) we can see that it is (**) sign a significant correlation between all variables. This time $p<0.01$ level. The main difference is the values between the performances. From the quality side, the strongest connection is with the delivery, R=0.507**, the weakest with costs, R=0.034**. From this result, I can predict that in the production quality creation, cost structure might change rapidly, because it depends on many factors as turnovers, delays, time changes. In this process includes delivery, and many final outcomes depend on the timing and connectivity.

Analyzing the delivery graph, the second-highest correlation number after quality is in flexibility, R.=0.443**, lowest – costs, R=0.343**. From the practical knowledge, ensuring flexibility in time and in communication with the customer, the supplier can create a better logistic chain. Transportation cost is an upbeat indicator, that is why the correlation is lower the flexibility.

From the flexibility graph, the highest connectivity is with the innovation sector, R=0.515**. New technologies and innovations can increate and influence a better manufacturing process. As well as we can see in the costs graph, the connection is with the innovation, R=0.45, the highest comparing from all other variables.

To summarize the (13 Table) I saw the highest correlation connection between the flexibility and innovations, R=0.515** and lowest in flexibility and costs, R=0.266**. As I mentioned before, the cost structure can change quickly if there are any unplanned tasks and errors in the process. All these 5 elements which are mentioned in the table are connected with each other and making an influence on the final outcome – profit. If I would make a connection map, it would look like a star. If one process will stop, it can influence all 4 remaining elements. The connection between the variables shows the importance of each other cooperation. This is why many businesses, manufacturing industries afraid of making changes and new methods implementation because then might appear more errors, time delays and money lost. But as we saw from the (13 table cost structure has the lowest influence on the manufacturing process). In the (13 table, which is below.) I will check the correlation between the technologies and the performance dimensions. The main reason for this comparison is to see if these systems/machines can influence manufacturing process performances. If yes, which one of them can do the effect and how strong it is.

Correlation between DMT and performance dimensions:

Table 14. Spearman correlation analysis for all variables

		Mob.	DG	ERP	EDI	MES	RFID	Q	Del	Flex.	C	Inn.
Mob.	CF.	1.000										
DG	CF.	.170	1.000									
ERP	CF.	.126	,397*	1.000								
EDI	CF.	.261	,482**	.309	1.000							
MES	CF.	-.084	.307	,452**	-.019	1.000						
RFID	CF.	-.003	.401	,702**	.183	.058	1.000					
Q	CF.	.046	-.096	-.012	.207	-.213	.253	1.000				
Del.	CF.	.086	,288*	.146	,286*	.181	.209	,507**	1.000			
Flex.	CF.	.136	.046	.162	.262	-.019	.258	,407**	,443**	1.000		
C	CF.	.065	.108	.110	-.103	-.083	,423*	,304**	,343**	,266**	1.000	
Inn.	CF.	-.005	.120	.122	.151	.119	.282	,400**	,428**	,515**	,455**	1.000

**Correlation is significant at the 0.01 level

*Correlation is significant at the 0.05 level

Mob-Mobile devices, DG –Digital solutions, Q – Quality, Del –Delivery, Flex – Flexibility, C-Costs, Inn – Innovations, CF- correlation coefficient.

In this (14 Table) we can see all results: technologies influence the technologies, manufacturing performance to the performance activities. The third analyzes, do any of the listed technologies have an influence on the performance dimensions?

The graphs I will analyze I marked in the squire. From the mobile devices graph, I can see there is no correlation. In DG (digital solutions) graph with Del. (delivery), I have a valid number – R-0.288*, which is $p<0.05$. DG influences the delivery process. There is also a connection between the EDI system and Del. process, the correlation is $p<0.05$ and R-0.286*. DG and EDI have almost the same correlation significance. From the table I can see the highest correlation significance between RFID, logistics solution system and cost structure: $p<0.05$ and correlation R-0.423*. As we can see there are just 3 connections, 2 with the delivery and one with the cost. To mark it:

- Digital solutions have positive impact to the delivery
- EDI have a positive impact to the delivery
- RFID have positive impact to the costs.

There are just a few connections, the answers why it is like that might be:

First – it is not sure how many connections it could be in practice,

Second - results can influence mediators,

Third – results can influence the missing number.

Summarizing all three tables' results, we can see that digital technologies can influence each, but mobile devices we can separate in another category as a machine. ERP, MES, and RFID have the highest connectivity between each other, as we saw from the correlation coefficient. Than digital solutions and EDI. From my literature review, I had 3 hypotheses: mobile devices and digital solutions/documents/ ERP and MES/ EDI and RFID have a positive effect on the quality, delivery, flexibility, costs. From 14 Table we saw that statistically from the correlation results, we couldn't find some technology connections with the manufacturing dimensions.

4.4 The DMT impact on competitive performance

In total, I have 3 hypotheses which are mentioned in the second chapter. In this hypothesis is included 6 digital technologies, which I will analyze separately. The main meaning was to check does the raised hypothesis will be supported or rejected from the data results. I had 5 categories of dependent variables: quality, delivery, flexibility, costs, innovations, and 5 as this case-independent: digital devices, documentation, ERP, MES, EDI. RFID. To check the results, I used multiple linear regressions to carry out statistical data analysis by Hayes's (2012). Using the author's model by the SPSS program, I analyzed Anova, Model summary tables.

But before I want to explain the meanings of the data which is written below:

F(from Anova df graph, 1 number – regression, second – residual result)= meaning. Also from the Anova table I used data for p=Sig. Model summary I used Adjusted R square data information which is written (R2). The results we can see below:

- Quality: $F(6, 188)=1.678$, $P>0.05$, ($p=0.129$), $R2=0.05$;
- Delivery: $F(6, 184)=1.304$, $P>0.05$ ($p=0.257$), $R2=0.04$;
- Flexibility: $F(6, 179)=0.892$, $P>0.05$ ($p=0.502$) $R2=0.03$;
- Costs: $F(6, 179)=0.956$, $P>0.05$ ($p=0.457$) $R2=0.03$;
- Innovations: $F(6, 180)=0.742$, $P>0.05$ ($p=0.617$) $R2=0.024$. (2 appendix)

In this upper research findings, it was included 6 digital technologies were analyzed what influence it has to the manufacturing performance outcomes. The significance is low as we can see from the p meaning. R sq, the highest result is in quality – 0.05, the lowest in innovations - 0.024. R2 – in other words, can be described as a valid, predicted percentage. From the compiled data, the results are no significant, that is why I will analyze technologies influence the performance achievements separately according to the regression model. In (15 table) there are summarized all data results from the researches. I will start to analyze from the quality.

Table 15. Linear regression coefficients (made by author)

	QUALITY		DELIVERY		FLEXIBILITY		COSTS		INNOVATIONS	
Model	Coefficients		Coefficients		Coefficients		Coefficients		Coefficients	
	B	Sig.	B	Sig.	B	Sig.	B	Sig.	B	Sig.
(Constant)	3.269	.000	2.435	.000	2.888	.000	3.000	.000	2.285	.000
Mobile devices	.016	.890	-.017	.869	.057	.617	.023	.792	.032	.778
Digital doc.	-.099	.374	.107	.293	-.061	.577	.097	.246	.030	.784
ERP	-.092	.498	-.070	.569	.035	.793	-.007	.945	-.006	.966
EDI	.225	.123	.210	.112	.232	.104	-.067	.536	.121	.391
MES	-.179	.135	.111	.308	-.030	.797	-.108	.226	.056	.631
RFID	.294	.055	.174	.208	.175	.243	.171	.134	.226	.130

I had a hypothesis that Digital manufacturing technologies have a positive impact on manufacturing performances. From the (15 table) I have only one significant result in the quality sector with the RFID technology. SIG- 0.055 and B- 0.294. According to the data results, I can say that all hypothesis is rejected except that RFID has a positive impact on the quality.

In this research was analyzing how the technologies can affect activities performances and from the received results we saw that technologies can influence final results from 2.4% to 5%. The other 97% or 95% is influenced by other factors. To make deeper researches and achieve more connection between the technologies and manufacturing processes I decided to analyze with the regression model separate activities performance and digital manufacturing elements. The significant result will be counted until p<0.1. But before some explanation about the table results:

ANOVA model summary – F (regression, residual) =F meaning. From Anova I used coefficient (p=sig), Model summary R2=R square. From the coefficient table – Connected technologies I was analyzing connection and signification meanings. Results are visible in 16 Table:

Table 16. Significations between the DMT and activities performances (made by author)

Name	Anova, Model summary	Anova Sig..	R^2	Coefficient P / Connected Technologies
Product reliability	F(6, 194)=2.158,	p=0.049/**p<0.1**	0.063	(RFID) p=0.023, B=0.399
Product features	F(6, 190)=1.996	p=0.068/**p<0.1**	0.059	(EDI) p=0.051, B=0.305 and (RFID), p=0.038, B=0.342
Product conformance	F(6, 196)=1,785	p=0.104/p>0.05	0.052	RFID p=0.029, B=0.372
Product durability	F(6, 193)=1,918	p=0.080/**p<0.1**	0.056	(EDI) p=0.047, B=0.314
Delivery availability	F(6, 187)=1,491	p=0.183/p>0.05	0.046	(EDI) p=0.047, B=0.314
Delivery speed	F(6, 189)=1,289	p=0.264/p>0.05	0.039	(EDI) p=0.022, B=0.336
Unit costs	F(6, 180)=1,297	p=0.261/p>0.05	0.041	(MES) p=0.053, B=-.196
Adjust product volume	F(6, 183)=1,372	p=0.228/p>0.05	0.043	(Mobile devices) p=0.047, B=0.254

I made extra regression analysis to check how technologies can influence activities performance in a specific sector. I received positive results in production quality sector. From Anova table $p<0.1$ were in product reliability, features, durability sections in other section it was $p>0.05$. In (16 Table) we can see a significant connection also with other fields and technologies. For example, in a deeper analysis of the production quality I can see positive and significant results which are $p<0.1$ with RFID, EDI technologies. R2 explaining how rational is this information. From the table graph it is valuable around 5-6% and has an influence on the production quality. In delivery availability and speed more influencing EDI suppliers' communication system. In unit costs, the MES system has less significant that $p>0.05$, because the p result is 0.053, it is overcoming the limit. Adjust product volume is in the flexibility part, from the Anova sig column the p result is >0.05, but comparing it with the connection with the technology it is connected with the mobile devices.

Before the analyzed information was more general, after separate performance elements were combined in one to see the connections. For production quality technologies as RFID and EDI have a significant $p<0.1$ influence to the manufacturing performance, because the received p are: 0.023/ 0.038/ 0.051/ 0.047 sig results. Connections were found: product reliability, features and durability with EDI and RFID technologies. It is saying that in a delivery sphere the most important is the time and communication and from coefficient graph $p=0.047$, b- 0.314 and having an even stronger significant result with the speed, $p=0.022$, $B=0.336$. This result shows that there is a 3.9%-4.6% technology influence to delivery performance. But looking in Anova graph, the result is not significant, because it is $p>0.1$. There is around 4% probability that MES has a positive influence on the unit cost reduction in the manufacturing process. Many time in manufacturing process volumes, orders are changing and it is necessary to make changes, that‘s fly flexibility and adjustment of volume have high importance in the manufacturing site.

CONCLUSIONS AND RECOMMENDATION

CONCLUSIONS

1. From analyzed literature and authors reviews, and researches were find out that 4.0 industry revolution and CPS became more important and necessary in the manufacturing industries performance. The new description appearing as modern manufacturing, which is influenced by business model changes in industrial sectors and becoming as trend. Due to internal manufacturing changes manufacturing companies need to adjust new devices and technologies in specific sections: control, planning/ scheduling, communication with the suppliers, customers, management in logistic, costs, and entire processes. According to the research, manufacturing companies who are implementing manufacturing process systems and tools achieve a better competitive impact on performance compared with other companies. Using this information, I created a questionnaire to check how is real this literature review.

2. From a theoretical perspective, digital manufacturing technologies have a positive impact on the manufacturing industries in various fields. The positive impact is more visible in large entertainments, because these companies can invest more money and time to wait for better results in the future. From the author's researches positive results are achieved in many industrial sectors like construction, logistics, and production by reducing cost, time, and space and response rate of operations. CPS and digital operations combined with the management allow to react as quickly as possible because time becoming one of the most important aspects in the business. Competitive performance is creating by offering similar or better service, production or releasing products faster than competitors. Due to achieving a competitive advantage, companies are investing in digital technologies, implementing changes in structure. One of the reasons why companies are willing to implement changes - because, from the theoretical researches, digital devices, technologies might improve various manufacturing activities performances in time, cost reduction and increase flexibility.

3. It was created a grounded conceptual model which was divided into 2 columns, first Digital manufacturing technologies and the second – manufacturing achievements performances. This survey was also created to compare different industries to see how companies are accepting the newest technologies, what competitive performance it can create and what kind of technologies are implemented. Using a created model and methodology I determined the relationships between the digital manufacturing technologies and activities competitive performances comparing with the competitors received from survey data. It was used as a quantitative research method to receive qualitative information from the manufacturing industries. The main research goal was to analyze what is creating competitive performance in the various industries and what is necessary to implement in manufacturing organizations. Improved organizational achievements allow become more competitive in the market, perform more efficiently, reduce costs and increase profitability. Companies orientate into the consumer due to creating specific quality that is why of the goal nonstopping improvements in various sectors to reach long-lasting competitive performance. From the received data results comparing with Roger (2011), the questionnaire questions I categorized in 5 activities performances: quality, delivery, flexibility, costs, innovations which allowed me to have more specific information. These categories allowed determining Digital manufacturing technologies impact manufacturing and competitive performance. The highest positive impact is

visible in collaboration between the organizations, flexibility creation in a manufacturing organization and process management.

4. From the carried out empirical research data and information, it was revealed a positive impact of digital technologies performance in manufacturing industries. From 217 respondents' answers, it was counted information that around 30-40% of the industries are using digital manufacturing technologies. I analyzed 6 digital technologies and from around 50 % of respondent's reviews mobile wireless devices, documentation, ERP, EDI and RFID have medium system usability in the manufacturing site. Also, ERP – 44% and digital solutions -37% were categorized as high importance in the operating process, which are showing a positive impact of these technologies in practice. Competitive performance can be achieved in many ways and sectors, I analyzed 5 categories: quality, delivery, flexibility, cost, and innovation. Around 60% of industries having similar service or production in quality, delivery cost, and innovations that is why the production in the market usually is so similar. Manufacturing companies trying to create better service in the flexibility area and reduce cost structure. To achieve it, companies are investing in technologies and innovations. From the correlation result, I received information that technologies closely connecting and adding value to each other. For example, ERP has a significant connection with MES and RFID systems and having a positive influence no the digital solutions and this element connecting with EDI. Analyzing separately activities performance received a significant connection between all the elements; this result shows that if one process is influenced negatively, all results would be affected. This is one of the answers why manufacturing industries are not making cardinal changes in the system because then the company can receive negative results and lose competitive performance in the market. To avoid negative results, companies are deeply investing in research, how to create a positive impact on manufacturing performances. From the received data and analysis I got the answers that the delivery sector can be impacted positively by integrating digital solutions and the EDI system and in cost, a structure can make influence the RFID system. Digital manufacturing systems can make positive relationships and impact on the manufacturing technologies in competitive performance, but it all depends on the industrial field, categories product or service specification.

RECOMMENDATIONS

- From the literature review, it was found out that all digital technologies have a positive impact to the activities performed, but it all depends on the company's size, assets, how much time the company can invest to wait to receive positive results. Before implementing technologies, companies need to be able to make and adjust internal changes.

- From the received and analyzed data results, the most important part between the seller and the customer is the communication availability and timing. These element creating flexibility and possibility to make quick changes in the entire process. Around 30-35% of the companies trying implementing flexibility as a competitive element and in this process cost structure can be reduced because avoiding failures.

- In my research was analyzed general categories and the significant rate was implementation validation from 3% till 5 % of the digital manufacturing technologies compared with the competitive performance. To receive more specific accuracy results, independent variables as performance activities could be divided even in smaller categories as I did in 15-16-17 tables**.**

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APPENDICES

1 Appendix . Questionnaire

Fraunhofer ISI

Europos gamybos įmonių tyrimas

Tyrimas 2018

Ši apklausa yra dalis Europos gamybos įmonių tyrimo, kuris vykdomas visoje ES. Tyrimą koordinuoja Fraunhofer tyrimų instiututas Vokietijoje. Tyrimą Lietuvoje vykdo KTU bendradarbiaujant su Lietuvos pramonininkų konfederacija, Lietuvos inžinerinės pramonės asociacija. Jei klausimas netinka jūsų organizacijai, prašau atsakykite į juos atitinkamai "Ne" arba "0". Jeigu jūs negalite pateikti tikslių duomenų, pateikite apytikrius duomenis. Kiekvienas Jūsų atsakymas mums labai svarbus! Jeigu turite klausimų, prašau kreipkitės: Mantas Vilkas E-paštas: mantas.vilkas@ktu.lt, Tel: +37068792345

1 **Ar jūsų įmonė yra įmonių grupės dalis?**

☐ **ne** ☐ **taip** → Prašau atsakyti į klausimus apie šią įmonę, o ne apie visą įmonių grupę!

2 **Prašau nurodykite savo sektorių ir pagrindinius jūsų įmonėje gaminamus produktus.**

Sektorius (pvz., tekstilės, chemijos, įrengimų gamybos ir pan.)	Pagrindiniai produktai	Pagrindinių produkt pajamos % nuo vis pajamų, apytikriai
		aypt. ___ %

3.1 **Kalbant apie jūsų pagrindinius produktus, ar jūsų įmonė yra galutinių produktų gamintoja ar sistemų bei komponentų tiekėja, ar gamybos paslaugų teikėja** ► Pažymėkite, tik vieną atsakymą.

Galutinių produktų gamintoja
- fiziniams vartotojams ☐
- organizacijoms ☐ ilgalaikio turto produktai, įrenginiai
- ☐ veiklai skirti ištekliai / kiti produktai

Tiekėja
- ☐ sistemų tiekėja
- ☐ dalių/ komponentų tiekėja

Gamybos paslaugų tiekėja
- ☐ gamybos paslaugos (pvz., tekinimas, dažymas suvirinimas, šlifavimas)

3.2 **Jeigu jūs tiekiate savo pagrindinius produktus kitoms verslo įmonėms, kuriam pramonės sektoriui tiekiate daugiausia?** ► Pažymėkite, tik vieną atsakymą.

☐ Įrengimų gamybos ☐ Chemijos ☐ Automobilių Kitiems pramonės sektoriams ______

4 **Ar jūsų pagrindiniuose produktuose yra šių skaitmeninių elementų?**

	ne		taip
Interaktyvi valdymo sąsaja (pvz., valdymas balsu, duomenų pateikimas į išmanius akinius, virtualios/papildytos realybės sprendimai)	☐	—	☐
Interneto/tinklinis ryšys automatiniam duomenų apsikeitimui realiu laiku	☐	—	☐
Jutiklių, valdymo elementų papildomoms skaitmeninėms produktų funkcijoms	☐	—	☐
Identifikavimo žymių (pvz., RFID, QR ar barkodų)	☐	—	☐
Kitų skaitmeninių elementų: ______	☐	—	☐

5 **Kurios iš žemiau išvardintų charakteristikų geriausiai apibūdina jūsų pagrindinius produktus?**

Produktų projektavimas ir kūrimas ► Pažymėkite, tik vieną atsakymą.
- Asmeniškai pritaikomi prie klientų reikalavimų produktai ☐
- Standartizuoti produktai, apimantys tam tikras klientų pasirinktis ☐

Gamyba ► Pažymėkite, tik vieną atsakymą.
- Gamyba pradedama gavus kliento užsakymą ☐
- Galutinis produkto surinkimas vykdomas gavus kliento užsakymą ☐

10.1 **Kurios iš šių technologijų šiuo metu yra naudojamos jūsų įmonėje?**

Planuojama pradėti taikyti iki 2021 m.	ne	Technologijos	taip	Pradėta taikyti (metai) 1	Nuosekliai investuojama nuo 2015 m. ne	Nuosekliai investuojama nuo 2015 m. taip	Technologijos potencialo panaudojimas 2) (Ž=žemas; V=vidutinis; A-aukštas)
		Skaitmeninis gamybos valdyams					
		Mobilieji/belaidžiai įrenginiai įskirti įrangos ir įrenginių programavimui bei valdymui (pvz., planšetės)		19 / 20			l m h
		Skaitmeniniai sprendimai leidžiantys pateikti brėžinius, planus ar instrukcijas tiesiogiai į darbo vietas gamyboje		19 / 20			l m h
		Programinė įranga gamybos planavimui ir valdymui (pvz., ERP sistemos)		19 / 20			l m h
		Skaitmeninis duomenų apie produktus/procesus apsikeitimas su tiekėjais/klientais (Electronic Data Interchange EDI)		19 / 20			l m h
		Realaus laiko gamybos valdymo sistema (pvz. centralizuot gamybos ir įrengimų duomenų rinkimo ir analizės sistema, MES)		19 / 20			l m h
		Vidaus logistikos automatizavimo ir valdymo sistemos (pvz., sandėlio valdymo sistemos, RFID)		19 / 20			l m h

Įvertinkite savo įmonės pasiekimus lyginant su jūsų sektoriaus konkurentų pasiekimais

	Žymiai blogesnis /-ė	Blogesnis/-ė	Maždaug panašus/-i	Geresnis/-ė	Žymiai geresnis /-ė
Kokybė					
Produktų kokybė					
Produktų patikimumas					
Produktų funkcionalumas					
Produktų atitiktis specifikacijoms					
Produktų ilgaamžiškumas					
Pristatymas					
Pristatymo tikslumas (pristatomi tie produktai, kurie ir buvo užsakyti)					
Pristatymo terminų laikymasis					
Produktų išsaugojimas pristatymo metu					
Produktų turėjimas užsakymo metu					
Pristatymo greitis (nuo kliento užsakymo iki pristatymo klientui)					
Lankstumas					
Gebėjimas padidinti ar sumažinti gamybos apimtis					
Gebėjimas sureaguoti į pakeistus pristatymo reikalavimus					
Gebėjimas asmeniškai klientui pritaikyti produktus					
Gebėjimas teikti platų produktų asortimentą					
Naujų produktų gamybos paleidimo trukmė					
Sąnaudos					
Produktų gamybos sąnaudos					
Produktų gamybos pridėtinės sąnaudos					
Atsargų apyvartumas					
Inovacijos					
Naujų produktų pristatymo rinkai greitis					
Naujų produktų pristatomų rinkai kiekvienais metais skaičius					
Produktų inovatyvumo lygis					

2 Appendix. 60 page Tables -explanations

QUALITY

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,225[a]	.051	.021	.66718	1.924

a. Predictors: (Constant), Mobile devices, documentation, ERP< EDI< MES< RFID

b. Dependent Variable: Quality

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.480	6	.747	1.678	,129[b]
	Residual	83.685	188	.445		
	Total	88.165	194			

a. Dependent Variable: Quality

b. Predictors: (Constant), Mobile devices, documentation, ERP< EDI< MES< RFID

DELIVERY

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,202[a]	.041	.010	.60584	2.008

a. Predictors: (Constant), Mobile devices, documentation, ERP, EDI, MES, RFID

b. Dependent Variable: Delivery

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.872	6	.479	1.304	,257[b]
	Residual	67.536	184	.367		
	Total	70.407	190			

a. Dependent Variable: Delivery

b. Predictors: (Constant), Mobile devices, documentation, ERP, EDI, MES, RFID

FLEXIBILITY

Model Summary[b]					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,170[a]	.029	-.004	.65338	1.901

a. Predictors: Mobile devices, documentation, ERP, EDI, MES, RFID

b. Dependent Variable: Flexibility

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.286	6	.381	.892	,502[b]
	Residual	76.417	179	.427		
	Total	78.703	185			

a. Dependent Variable: Flexibility

b. Predictors: (Constant), Mobile devices, documentation, ERP, EDI, MES, RFID

COSTS

Model Summary[b]					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,176[a]	.031	-.001	.49764	1.857

a. Predictors: (Constant), Mobile devices, documentation, ERP, EDI, MES, RFID

b. Dependent Variable: Costs

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.420	6	.237	.956	,457[b]
	Residual	44.328	179	.248		
	Total	45.748	185			

a. Dependent Variable: Costs

b. Predictors: (Constant), Mobile devices, documentation, ERP, EDI, MES, RFID

INNOVATIONS

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,155[a]	.024	-.008	.65111	1.934

a. Predictors: (Constant), Mobile devices, documentation, ERP, EDI, MES, RFID

b. Dependent Variable: Innovations

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.887	6	.314	.742	,617[b]
	Residual	76.309	180	.424		
	Total	78.196	186			

a. Dependent Variable: Innovations

b. Predictors: (Constant), Mobile devices, documentation, ERP, EDI, MES, RFID