Federal State Institution of Higher Professional Education
Saint Petersburg State University
Graduate School of Management

FACTORS AFFECTING DIGITAL TRANSFORMATION OF MANUFACTURING COMPANIES

Master thesis by
2-year student of program
«Master in Management»
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Saint Petersburg 2021

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I, Maria Kozlova, second year master student, program «Management», state that my master thesis on the topic "Factors affecting digital transformation of manufacturing companies", which is presented to the Master Office and to be submitted to the Official Defense Committee for the public defense, does not contain any elements of plagiarism. All direct borrowings from printed and electronic sources, as well as from master theses, PhD and doctorate theses which were defended earlier, have appropriate references. I am aware that according to paragraph 9.7.1. of Guidelines for instruction in major curriculum programs of higher and secondary professional education at St.Petersburg University «A master thesis must be completed by each of the degree candidates individually under the supervision of his or her advisor», and according to paragraph 51 of Charter of the Federal State Institution of Higher Professional Education Saint-Petersburg State University «a student can be expelled from St. Petersburg University for submitting of the course or graduation qualification work developed by other person (persons)».

ЗАЯВЛЕНИЕ О САМОСТОЯТЕЛЬНОМ ХАРАКТЕРЕ ВЫПОЛНЕНИЯ ВЫПУСКНОЙ КВАЛИФИКАЦИОННОЙ РАБОТЫ

Я, Козлова Мария Александровна, студентка второго курса магистратуры направления «Менеджмент», заявляю, что в моей магистерской диссертации на тему «Факторы, влияющие на реализацию цифровой трансформации в промышленных компаниях», представленной в службу обеспечения программ магистратуры для последующей передачи в государственную аттестационную комиссию для публичной защиты, не содержится элементов плагиата. Все прямые заимствования из печатных и электронных источников, а также из защищенных ранее выпускных квалификационных работ, кандидатских и докторских диссертаций имеют соответствующие ссылки.
Мне известно содержание п. 9.7.1 Правил обучения по основным образовательным программам высшего и среднего профессионального образования в СПбГУ о том, что «ВКР выполняется индивидуально каждым студентом под руководством назначенного ему научного руководителя», и п. 51 Устава федерального государственного бюджетного образовательного учреждения высшего образования «Санкт-Петербургский государственный университет» о том, что «студент подлежит отчислению из Санкт-Петербургского университета за представление курсовой или выпускной квалификационной работы, выполненной другим лицом (лицами)».

(Student's signature)

06.06.2021 (Date)

ABSTRACT

Master Student's name	Kozlova Maria Aleksandrovna
Master Thesis Title	Factors affecting digital transformation of manufacturing companies
Educational Program	Master in Management Program
Main field of the study	Management
Year	2021
Academic Advisor's Name	Andrey V. Zyatchin, Candidate of Science, Saint-Petersburg University, 2010, Associate Professor, Department of Operations Management, Academic director of MBA Program
Description of the goal, tasks and main results	The main **goal** of the research is to identify factors which affect the process of digital transformation (DT) in manufacturing companies. To achieve this goal, several **tasks** were completed: • To study the most recent and relevant researches in the area of Digital Transformation of manufacturing companies for creation of a list of factors affecting digital transformation • To study the specifics of Digital Transformation in Russian manufacturing industry • To develop a structural research model of factors affecting Digital Transformation of manufacturing companies • To collect primary data and test formulated model • To develop strategical recommendations for manufacturing companies for successful Digital Transformation Achieved **results:** • Structural model of Digital Transformation in manufacturing companies consisted of 8 latent variables was developed. It includes main factors affecting DT: Innovative push; Attitude to DT and change; Competition; Responsiveness to customer needs and expectations; Corporate technology; Market condition; Alignment of Business & IS • Three factors with highest impact on DT in manufacturing industry were identified: Generalized and interconnected technology, Positive attitude to change and DT, Alignment of business and IT • Practical recommendations for manufacturing companies were developed. Recommendation include 4 areas: 1) Switching from unique, noncompatible technologies to generalized and simple one 2) increase of interconnectedness of corporate systems 3) Increasing of the positive perception of digital transformation and corporate change 4) Alignment of business strategy and IT strategy
Keywords	Digital Transformation, manufacturing industry, affecting factors

АННОТАЦИЯ

Автор	Козлова Мария Александровна
Название магистерской диссертации	Факторы, влияющие на реализацию цифровой трансформации в промышленных компаниях
Образовательная программа	Менеджмент
Направление подготовки	Менеджмент (Master in Management – MiM)
Год	2021
Научный руководитель	Зятчин Андрей Васильевич, Кандидат физико-математических наук, Доцент кафедры операционного менеджмента, Академический директор программ MBA
Описание цели, задач и основных результатов	Основной **целью** исследования является выявление факторов, влияющих на процесс цифровой трансформации (ЦТ) в промышленных компаниях. Для достижения этой цели были выполнены следующие **задачи**: • Изучить актуальные исследования в области цифровой трансформации производственных компаний для создания перечня факторов, влияющих на цифровую трансформацию • Изучение специфики цифровой трансформации в российской промышленности • Разработать структурную модель исследования факторов, влияющих на цифровую трансформацию промышленных компаний • Собрать первичные данные и протестировать разработанные модели • Разработать рекомендации для промышленных компаний для успешной цифровой трансформации Достигнутые **результаты**: • Разработана структурная модель цифровой трансформации в промышленных компаниях, состоящая из 8 латентных переменных: Инновационный толчок; Отношение к ЦТ и корпоративным изменениям; Конкуренция; Уровень ориентированности на потребителей; Корпоративные технологии; Состояние рынка; стратегическое согласование бизнеса и информационных систем • Были определены три фактора, оказывающие наибольшее влияние на ЦТ в промышленности: Простые и взаимосвязанные технологии, позитивное отношение к изменениям и ЦТ, стратегическое согласование бизнеса и информационных систем

	• Разработаны практические рекомендации для промышленных компаний. Рекомендации включают в себя 4 области: 1) Переход от уникальных, несовместимых технологий к обобщенным и простым 2) Повышение взаимосвязанности корпоративных систем 3) Повышение позитивного восприятия цифровой трансформации и корпоративных изменений 4) Согласование бизнес стратегии и стратегии информационных систем
Ключевые слова	Цифровая трансформация, Промышленность, Влияющие факторы

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INTRODUCTION

Research subject: Digital Transformation in manufacturing companies

Research object: The research is focused on the Russian manufacturing companies and international manufacturing companies operating in Russia.

Research goal and objectives: the main goal of the research is to identify factors which affect the process of digital transformation in manufacturing companies. In order to achieve this goal several objectives were formulated:

- To study the most recent and relevant researches in the area of Digital Transformation of manufacturing companies for creation of a list of factors affecting digital transformation
- To study the specifics of Digital Transformation in Russian manufacturing industry
- To develop a structural research model of factors affecting Digital Transformation of manufacturing companies
- To collect primary data and test formulated model
- To develop strategical recommendations for manufacturing companies for successful Digital Transformation

Research questions: Entire research would answer three main research questions:

1. What factors affect DT of manufacturing companies?
2. What factors have highest impact on digital transformation of manufacturing companies?
3. What factors outside traditional theories also have an effect on DT of manufacturing companies?

Research motivation, relevance and value: digital solutions become more and more firmly embedded in everyday corporate practice: mobile apps, online shopping, big data analytics, Internet of Things, artificial intelligence etc. Data collection, monitoring, automation and optimization of all possible processes are constantly performed, which, in turn, requires more and more intelligent systems, the development of which is significantly simplified by improved algorithms, powerful computers, and cloud storage. Never before has the world been so closely connected and so digitized as it is today. Digitalization is believed to be the most meaningful technological trend, which affects not only business but society as a whole [Parviainen P. et al., 2017].

Digitalization leads to the digital transformation (DT) of business (transformation of business models) as new technologies, digital innovation and digitalization has changed traditional business processes, corporate structures, relationships, products and services due to inevitable efforts of companies to adjust to rapidly changing world [Matt, C., Hess, T., & Benlian, A., 2015].

Therefore, such crucial, world changing phenomena as digitalization and digital transformation are actively studied by researchers and should be investigated even more.

Important area of research about digital transformation is investigation of drivers, barriers and success factors i.e. factors affecting digital transformation. Researchers try to answer such questions as "What force companies to adopt digital solutions?", "What are the most crucial factors affecting digital transformation?", "Why some companies are fail in the process of digital transformation?", "Which capabilities and resources are essential for successful digital transformation?", "How to conduct successful digital transformation". These issues are covered in the works of researchers such as Rogers E. M. ,Liere-Netheler K., Vogelsang K., Tornatzky L., Fleischer M., Packmohr S., Osmundsen K., Iden J., Bygstad B. and many others. Today, there are existing theories about factors affecting digital transformation. However, digital transformation is a new topic that is not fully studied yet. Moreover, the development of digital technology is ongoing, not finished process and therefore, the drivers and the key success factors of digital transformation also evolve through time [Reis J. et al., 2019]. Therefore, the topic is relevant. From academic perspective, proposed research will provide a deeper insight into factors affecting digital transformation of companies and their impact as well as will identify implicit factors, which were not previously discussed a lot. As a result, findings of the research will contribute to the enlargement and improvement of traditional theories about factors affecting digital transformation. Moreover, revealed insights into key success factors would be a good base for enlargement of theories about digital transformation strategies. From practical perspective, this research would be useful for business representatives who are interested in digital transformation of their companies or for those who strive to stay competitive and achieve competitive advantage. Research would propose practical and strategical recommendations for companies on how to digitally transform their business and what are the main preconditions for it.

CHAPTER 1. DIGITAL TRANSFORMATION AND AFFECTING FACTORS

Digital transformation (further DT) is a multilateral and complex term, which could be used in everyday business life with different meanings. Therefore, it's important to specify exact definition of digital transformation, which would be used and implied in this master thesis. Moreover, deep understanding of DT phenomena and of what is a factor affecting DT is necessary to be obtained. In order to achieve this following chapter would include review and analysis of existing researchers in this area. The focus is made on the most cited, popular and believed to be a "classics" in digital transformation research, as well as on the most recent works from reliable authors and sources.

1.1. Definition of Digital Transformation and related concepts

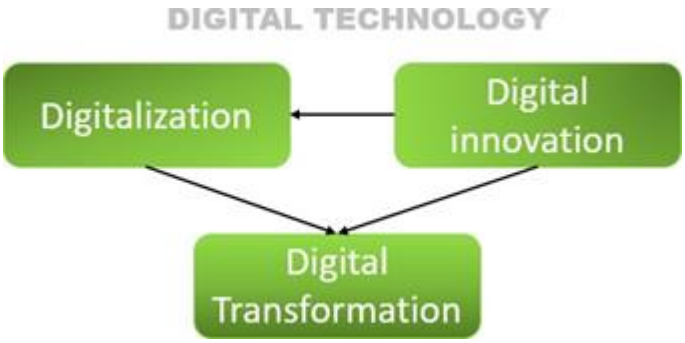
There are three terms in the area of digital transformation, which sometimes are confused with each other or consider to be interchangeable: digital transformation itself, digitalization and digital innovation. However, these phenomena are different things. Today, digital transformation couldn't be characterized with some single definition. However, researches are mostly agreed on its main essence. Digital transformation could be understood as substantial change in the organization which significantly modifies business model and is caused by, stands on and allowed by digital technology [Osmundsen K., Iden J., Bygstad B.,2018; Hartl , Hess, 2017; Mueller, Renken, 2017]. Several definitions of digitalization were studied. Clerck consider digitalization to be the use of digital technologies and of data with the purpose to improve financial & corporate performance, improve activities, transform business processes and establish an environment for digital business [Clerck,J.,2017]. Valenduc and Vendramin believe that digitalization is penetrating cooperative synergy of digital innovations altering economy and society as a whole [Valenduc, G., Vendramin, P., 2017]. Gobble defined digitalization as the use of digital technology and digitized information in order to create and yield business value in new ways [Gobble, M., 2018]. Srai and Lorentz stated that simple meaning of digitalization is the use of digital technology [Srai, J., Lorentz, H.,2019]. To summarize, digitalization could be described as adoption of digital technology and additional information in order to change and improve business operations.

Digital innovation could be defined as something new, previously not used by the company, that is based on the digital technology. Some researches define digital innovation as a process, and some as outcome. Combined approach could be more acceptable due to inclusiveness. It stated that "digital innovation is process and outcome of combination of digital technology in a new ways

or with physical components that enables socio-technical changes and creates new value for adopters" [Osmundsen K., Iden J., Bygstad B.,2018.].

To summarize simply, digital innovation is introduction of new digital technology to the company, digitalization is the process of change of daily operations and communications due to introduction of this new technology, and digital transformation is a major change in a company and its business model which happens as a result of digital innovation and digitalization[1]. Relationship of digital innovation, digitalization and digital transformation could be expressed as follows:

source: Osmundsen K. et al, 2018



Pic 1. *Conceptual model of digital transformation and related concepts.*

Both, digitalization and digital innovation have direct effect on digital transformation, while digital innovation is also a cause of digitalization.

1.2. Concept of Digital Transformation

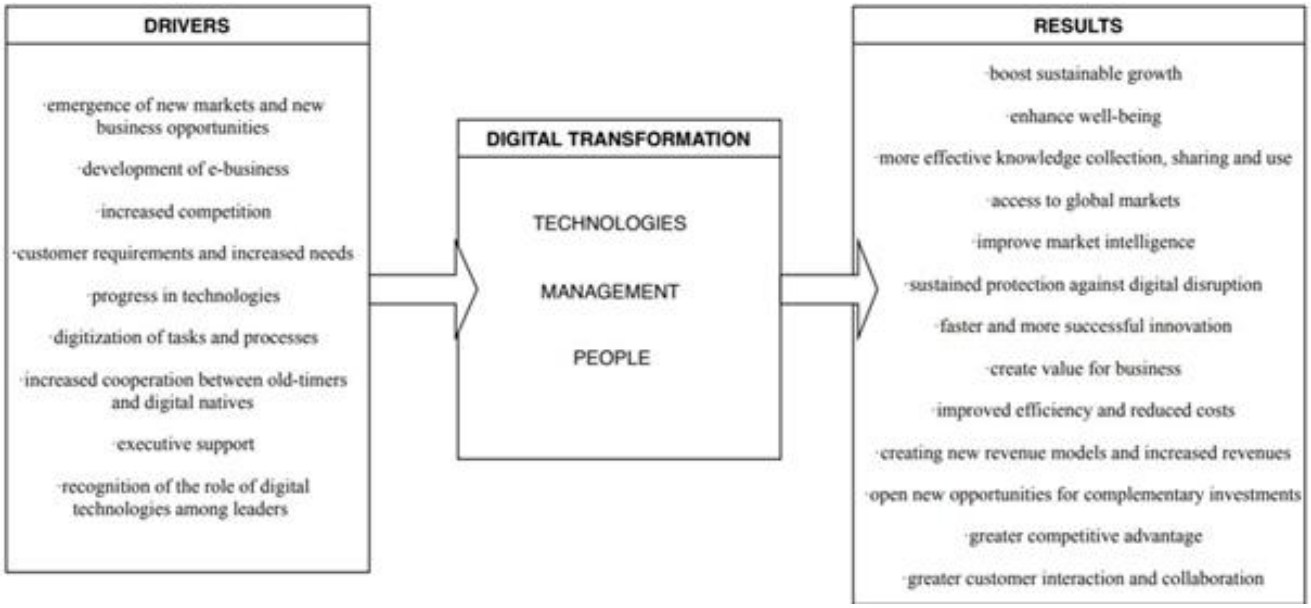
Conceptual understanding of DT is crucial for further in-depth research. Nowadays, there are several concepts of digital transformation striving to explain its essence: drivers, elements, parts, relationships and types. Natalja Verina and Jelena Titko (2019)[2] provide a conceptual model of digital transformation, which includes main drivers of DT, DT categories (Authors defined 3 categories of DT, which need to be aligned: people, process/management and technology), and outcomes of DT. In addition, based on the survey, authors range the factors affecting DT processes by importance. As a result, it appeared that most significant factors are: company's strategy; orientation towards digital transformation; organizational culture; company's values; self-

[1] Osmundsen, K., Iden, J., & Bygstad, B. (2018, September). Digital Transformation: Drivers, Success Factors, and Implications. In MCIS (p. 37)

[2] Verina, N., & Titko, J. (2019, May). Digital transformation: conceptual framework. In Proc. of the Int. Scientific Conference "Contemporary Issues in Business, Management and Economics Engineering'2019", Vilnius, Lithuania (pp. 9-10)

motivation of employees and readiness to accept changes. Schematically, model proposed my Verina and Titko could be depictured as follows:

source: Verina and Titko, 2019

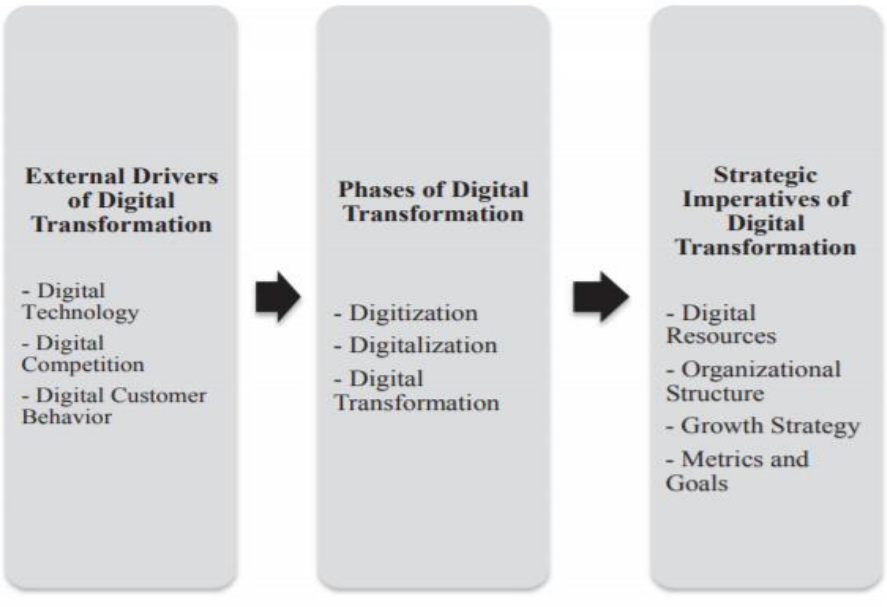


Pic 2. *Conceptual model of digital transformation by Verina and Titko .*

Verhoef P. C. et al.,[3] in their research called "Digital transformation: A multidisciplinary reflection and research agenda" published in 2020 provide a discussion of digital transformation based on the literature review. Summary of authors findings about digital transformation could be visualised in a following way:

[3] Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Dong, J. Q., Fabian, N., & Haenlein, M. (2021). Digital transformation: A multidisciplinary reflection and research agenda. Journal of Business Research, 122, 889-901

source: Verhoef P. C. et al., 2019

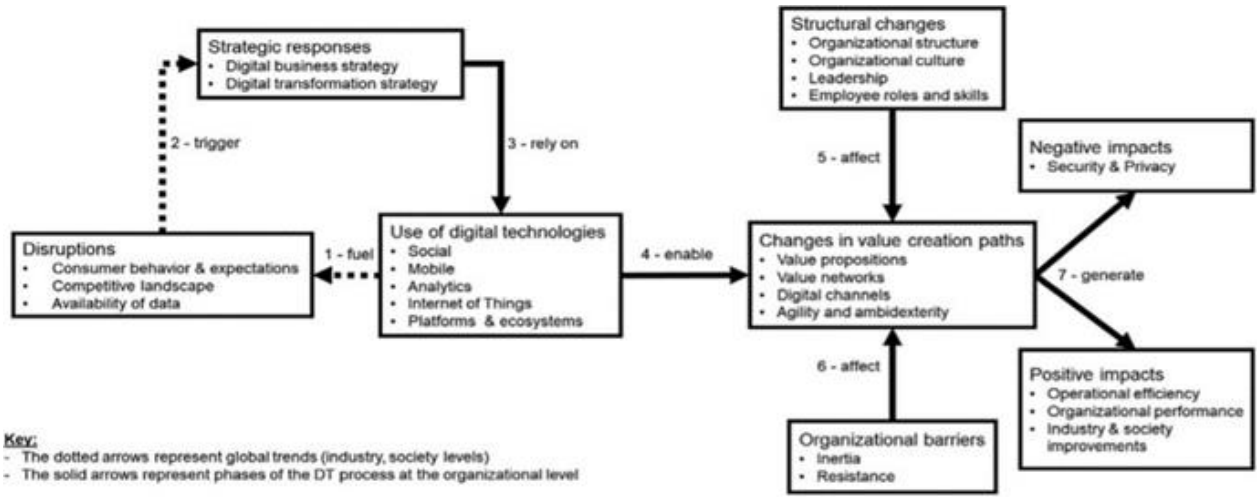


Pic 3. *Flow model of digital transformation by Verhoef P. C. et al..*

Authors mentioned three main drivers of digital transformation: digital technology which are now rabidly developed and adopted by companies, digital competition which increased as a result of digital technology introduction and rapid growth and, finally, digital customer behaviour which is changing in response to ongoing digital revolution and digital technology development. All this led to digital transformation, which could be divided into 3 evolutionary steps: digitization, digitalization and DT. Digitization implies the encoding of analog information into a digital format that computers can store, process, and transmit such information (Dougherty & Dunne, 2012; Loebbecke et all., 2015;). Digitalization, as it was mentioned earlier, is the process when digital technology alters existing processes. After digitization and digitalization comes the Digital Transformation. Based on this concept, Verhoef P. C. et al. described the strategic imperatives of a company and their influence on digital resources, organizational structure, growth structure, metrics and goals. Authors mention that from the perspective of resources and capabilities necessary for DT, company needs : digital assets, digital agility, digital networking capability and big data analytics capability. From the perspective of organizational structure, DT requires more flexible structures with separate business units, agile organizational forms, and digital functional areas. From the perspective of growth strategy research focus on the impact and success of digital platforms. Finally, digital transformation requires development of new system of goals and metrics that are focused on the digital side of business: KPIs for online communication and distribution channels, KPIs for data driven internal softwares, KPIs etc.

Other researcher, Gregory Vial (2019)[4] developed a framework, which depict digital transformation as a process where digital technologies lead to disruption, that cause strategic responses from companies, which aimed at finding new ways of value creation through managing the structural changes and internal. Framework also states positive and negative outcomes of this process. Framework is presented on the following picture:

source: Vial G., 2019



Pic 4. *Conceptual framework of digital transformation by G.Vial.*

According to G.Vial appearance and adoption of digital technology lead to disruptional changes in consumer behaviour because of unlimited access of consumers to information and communication (through social media, portals etc.). This fact makes consumer closer to organization and its main stakeholders and involve them into the active interaction. As a result, customer expectations and behaviour have changed. Second disruption which is initiated by digital technology is the change of the markets. Companies develop new digital products and services, introducing to the consumers innovations and digital infrastructures. In addition, markets are shifting towards prevalence of services rather than products [Barrett et al., 2015]. As a result of market reorganization, competition moves from physical battle to more virtual (for example, instead of physical distribution and marketing channels, online channels appeared and gained higher popularity in some industries), with the fight for data analysis and digital advantage, strong position in digital infrastructure, and an access to digital platforms. Third disruption is growing access to data: productions can instal special sensors and detectors for maintenance of production, which in addition generate data about everyday manufacturing operations, apps and website

[4] Vial, G. (2019). Understanding digital transformation: A review and a research agenda. The Journal of Strategic Information Systems, 28(2), 118-144.

generate data about consumers and their activities, mobile devices generate data about its users etc. All this data could be collected and analysed in order to achieve competitive advantage and improve corporate performance. Furthermore, such data became a product and sometimes is sold to interested parties.

These 3 main disruptions lead to the corresponding strategic response of companies such as digital business strategy, which implies inclusion of digital part into business strategy, and digital transformation strategy, which implies deliberate step by step business model change. These strategic responses initiated an even deeper dive into the world of digital technology and consequential global disruptions.

Mentioned disruptions result into structural changes in a company. Firstly, organizational structure becomes more horizontal, less centralized, more flexible and agile. Important place is diverted to cross functional collaboration and matrix, network structures. Secondly, organizational culture also affected by digital technology. Importance of promoting among employees agility principles, constant learning, innovativeness, proactiveness, desire to risk and experimenting. In addition, requirements for leadership also changed. Now, organizational leaders "must work to ensure that their organizations develop a digital mindset, while being capable of responding to the disruptions associated with the use of digital technologies" [Benlian and Haffke, 2016]. Last structural change resulted from digital technology adoption and strategic responses is modification of employees' roles and consequent change in required skills. Digitalization and digital transformation leads to the appearance of absolutely new roles (system analytics, social media marketers etc.), as well as reformulation of existing ones. Thus, for example, employees previously not being a part of IT department, could be responsible for digital functions and projects. Respectively, need in new skills and cross-functional competence become essential.

Mentioned structural changes and disruptions provide new ways of value creation. Value propositions become more service and customer oriented. Value networks digitalized and now include digital parties instead of previously physical ones. Sometimes networks became digitally based (in case of platforms). This allows a co-creation of value with main stakeholders. Digital distribution, sales and marketing channels are coming to the fore and impact the process of value generation. Finally, from the perspective of changes in the value creation paths, companies become more agile and ambidextrous because of digital technology. They could more rapidly and flexibly detect and seize the opportunities. Data analytics and Internet of Things help companies to become proactive and more effective.

Authors also mention that in addition to facilitators of digital transformation there are also barriers, such as inertia and resistance. Interia implies the situation when existing resources (tangible and

intangible) discourage digital transformation. For example, company could has solid relationships with it's distributors (physical) and overall business strategy is based on this relationship. For such company transfer to digital distribution channels would imply significant reorganization of all business process. Other example, could be company with really expensive and hardly developed but effective production facilities, which could not be digitilized because of technical peculiarities. However, at the same time, competitors already actively digitilize their production process and actively collect data for generation of new level competitive advantage. In these situations of interia, current resources become a barrier for change. Second barrier is the resistance from the side of employees, who could not be ready for upcoming innovations.

Finally, G.Vial discuss the positive and negative impacts of DT. Among negative he mentioned privacy and security, which could be harder controlled in a digitalized company. Among positive impacts author mentioned company level aspects: efficiency and performance improvement, and global level impact: industry and society improvements. The latter refers to benefits, which digital technology provides in case of mass adoption by industry players (most obvious examples are healthcare industry or improvement of quality of life in rural areas in developing countries due to appearance of cheaper and accessible services).

All in all, these concepts are quite new and based on previously developed models and their improvements. They together provide an actual and in-depth explanation of what is Digital Transformation, its categories, main relationships and effects.

1.3. Digital transformation in Russian manufacturing

Today, the Russian Federation is one of the leading powers in the world. According to its potential, the country's industry is able to establish the production of a wide range of goods that provide the most important areas of the population's life. Despite the severe systemic crisis of the 90s, accompanied by a significant decline in industrial production, since the beginning of the 2000s, a steady trend of growth and development has been recorded in manufacturing segment. Russia closes the top four, behind China, the United States and India in terms of production. The most developed branches of the Russian industry are the oil and gas sector (23% share in manufacturing industry), ferrous and non-ferrous metallurgy (17%), general, transport and equipment engineering (31%), and food production (16%)[5].

[5] Rosstat. Federal State Statistics Service - the Russian federal executive body responsible for gathering official statistical information in the Russian Federation. Access: https://rosstat.gov.ru/ (date:13.12.2020)

Mechanical engineering is a key manufacturing industry in the country. Leading machine-building enterprises are located in large cities and industrial zones of Central Russia, the Volga region, the Urals, Western Siberia and Primorye. The share of mechanical engineering in the total volume of industry is about 30%. In turn, the machine-building complex includes more than 70 different sub-sectors. Mechanical engineering currently has a fairly serious production capacity and scientific base. However, compared to the Soviet period, the country recorded a significant decrease in production volumes, which is due to increased competition from foreign suppliers, the wear and tear of the machine fleet, and financial problems of enterprises. The implementation of the import substitution program adopted by the government of the country provides for bringing the industry to a new level that meets modern standards.

Russia is one of the world's largest producers and exporters of oil products. There are more than 100 oil refineries of various capacities operating in the country, providing oil products to the population and enterprises of Russia, as well as exporting their products. Due to the growth of oil production in the last decade, there is a steady trend of increasing the production of the main products of oil refining – gasoline, diesel fuel, heating oil and lubricants. Russia's largest oil and gas fields are located on the West Siberian Plain and the Yamal Peninsula. Metal ores are concentrated in the Urals, in Western Siberia and in the area of the Kursk magnetic anomaly. The country's coal basins are Kuzbass, Vorkuta, the Elginsky field in Yakutia and the Elegestskoye field in the Republic of Tyva. Mining is the important branch of Russian industry, providing a significant part of the country's GDP. Russia is considered one of the world leaders in the production and export of oil and natural gas. It has significant amounts of mineral resources, such as oil, gas, coal, metal and non-metal ores, and diamonds. The volume of value added in this segment of the industry exceeds 3.5 trillion rubles.

The food industry is also one of the most important branches of the domestic industry, specializing in the production of food products, semi-finished products, tobacco, alcoholic and non-alcoholic beverages. It includes more than 30 sub-sectors, the most important of which are meat-dairy, fish, flour-milling, and food-tasting. The leading enterprises are located in the major cities of the country and the basic centers of agricultural production. The Russian food industry, in general, is focused on the domestic consumer. In terms of quality, the products of the domestic food industry successfully compete with imports, and in a number of segments surpass products supplied from abroad.

From the perspective of manufacturing digitalization, there are several areas which are now actively developing. First, big data analytics. It allows to collect and analyze all data generated in manufacturing process: plant operations (production time, temperature, equipment statistics etc.),

movement of stocks, logistics status, costumer characteristics. This data could be collected using Internet of Things (computer network that combines various kinds of physical objects through smart sensors or/and software, that can interact with each other and the outside world)or special software and devices. For analysis of this data special software's (Power BI, Qlick View, ERP etc.)and approaches (data science, math modeling, statistics) could be used. Second area is development of "smart factories" – factories, which represent connected network of equipment, machinery and corporate systems. This concept is also close to Internet of Things. Ideal digitalized manufacturing implies fully connected ecosystem, which use digital technologies for increase of business value[6].

Currently, Russian government actively support digital transformation of manufacturing. On August 5, 2020, it became known about the approval of the first standards of the digital industry in Russia. They were developed by the technical committee "Cyber-Physical Systems" on the basis of RVC with the support of the Ministry of Industry and Trade of the Russian Federation. According to the ministry, the standards are aimed at the effective implementation of digital technologies in the Russian industry, the development of high-quality and independent solutions, as well as ensuring their compatibility.

In 2020, the Digital Economy organization, together with the Ministry of Industry and Trade of Russia and the Cifra Group of Companies, conducted a study aimed at identifying obstacles to the digitalization of Russian production. Most of all, the surveyed experts noted the high cost of IT solutions for the digitalization of production processes, the insufficient level of digital maturity of business employees and the disruption of supply chains.

The companies see the high cost of digital transformation projects as the main obstacle to the digitalization of the industry. Two other pressing issues-the inherently low level of automation and digitalization, and the distrust of employees who resist change.

According to the study, training of personnel to work with digital services and improving computer skills will help to overcome the voiced problems. The second way to overcome the problems on the path of digitalization is to provide financial benefits and incentives to business from the state. The third method is the modernization of production and the creation of integrated digitalization strategies by enterprises. Amendments to the regulatory regulation as a way to solve the problems of the industry were named by 18% of respondents.

[6] Morkovkin, D. E., Gibadullin, A. A., Kolosova, E. V., Semkina, N. S., & Fasehzoda, I. S. (2020, April). Modern transformation of the production base in the conditions of Industry 4.0: problems and prospects. In Journal of Physics: Conference Series (Vol. 1515, No. 3, p. 032014). IOP Publishing.

The greatest interest by Russian companies is in favor of production technologies. In more detail, the highest attention is payed at resource management, organizational capacity management (engineering, design), and data management about the product and its lifecycle. In addition, Russian companies interested in industrial robotic complexes and the Internet of Things.

Probably, due to the fact that the main problems for companies (in addition to the high cost of IT solutions) are issues related to the digital maturity of employees and managers of organizations, as well as the general low level of automation-enterprises are interested in technologies to improve the efficiency of employees through digital management technologies. AI, cloud technologies, AR / VR, and distributed ledger systems are less likely to have properties that are valuable for enterprises in terms of digitalization[7].

1.4. Theories about factors affecting digital transformation

In order to start the in-depth analysis of theory about factors affecting digital transformation, it's necessary to understand what is a factor. According to the dictionary[8], factor is one of the circumstance, condition or influence that contributes to a result. More deeper understanding could be gained from theory about casual relationships, there cause could be seen as an independent variable and effect as dependent one. It states that there are three criteria for identification of such relationships[9]. First is association, which tells about if there is a relationship between dependent and independent variables. This could be checked for example with correlation calculation. Second is time order. It means that cause should happen before the effect. Third is non-spuriousness criteria. Spuriousness is a such situation that happens than 2 variables are proven to be in association, however in reality this association is a cause of other, third variable. For example, if we check the relationship between probability of death and number of wrinkles, we would reveal an association. However, in reality, both these things are effects of ageing, and do not have a cause and effect relationship.

In this entire master thesis under factor the following would be understood: a situation, aspect, thing and circumstance which appear to be the cause of digital transformation or/and the cause of certain success level of DT and the way how it flows.

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[7] Tadviser. Digitalization of manufacturing in Russia. 2020

[8] Factor definition. Dictionary.com– Access: https://www.dictionary.com/browse/factor (date:11.09.2020)

9 Establishing Cause and Effect. Statistics Solution – Access:https://www.statisticssolutions.com/establishing-cause-and-effect/ (date:13.09.2020)

Even though digital transformation is quite modern topic, there are already some theories existed and related to the field of factors affecting digital transformation. Existed theories could be divided into two categories: theories about drivers of digital transformation and theories about key success factors of digital transformation.

Most popular (mostly mentioned in researches) theories and models about drivers of digital transformation are Diffusion of Innovation Model (DOI), Technology, Organization and Environment Model (TOE).

Diffusion of Innovation theory was developed by Everett Rogers back in 1962 and expanded in 1996 by the author. Initially it was developed to explain adoption of any innovation, but later was adjusted for IT and digital technologies. This theory explains how and due to which factors technology and digital innovation is adopted by companies. As it was revealed in paragraph 2.1, adaptation of digital technologies has direct effect on digitalization and digital transformation of organizations. Therefore, this theory could be a good base for understanding of drivers of digital transformation. According to DOI theory, main factors of digital technology adoption are individual characteristics (attitude towards change), internal organizational characteristics (these could include level of company's formalization and centralization, company size, slack, interconnectedness and overall complexity) and external characteristics (including system openness) [Oliveira T., Martins M. F., 2011].

Technology, Organization and Environment Model was created by Tornatzky and Fleischer in 1990. As well as DOI theory, TOE model strives to explain the way how company will adopt new technological innovation based on the state of core drivers. TOE model stated that there are three main contexts influencing the digital innovation of a company: technological, organizational and external. Technological context includes internal and external technologies referred to the firm: equipment, tools and technologies used and available to the company. Organizational context includes internal characteristics similar to DOI model: size, structure, slack, communication etc. External context refers to macro and business environment of a company: industry and market conditions, governmental regulation and technology support infrastructure [Tornatzky L., Fleischer M., 1990]. According to Gillani F. et al. (2020) organizational, technological and external contexts are not separate perspectives which affect DT, but technological context is a mediator of organizational and external impacts of the company (i.e. organizational and external factors influence DT through technological factors).

Both DOI and TOE model emphasized internal organizational factors and external factors as a core drivers of digital technologies adoption by companies. However, DOI theory has also a focus on individual attitude to innovation, while TOE model pay more attention to external and

technological factors. These two theories have became a base for deep investigation of organizational and external environment factors in digital technology acceptance and adoption by various researchers [Ehie I. C., Chilton M. A., 2020]. Review of literature showed that usually researches combines these two theories to explain the drivers of digital technology adoption and consequent digital transformation of a company. Most significant drivers of digital transformation are appeared to be changes in customer behavior and their expectations (external factor), digital changes in trends in the industry(external factor), shifts in competitive landscape (external factor) and changes in regulation (external factor), that is more close to TOE model [Osmundsen K. et al, 2018].

Based on the existed theories, several researches devoted to drivers of digital transformation were conducted. Thus, Osmundsen, K et al. (2018) concluded that main drivers of DT are: customer behavior and expectations, digital shifts in the industry, changing competitive landscape, regulative changes, and usual companies' objectives such as to: ensure digital readiness, digitally enhance products, embrace product innovation , develop new business models, improve digital channels, increase customer satisfaction and dialogue. Other researchers, Davydenko I. et al. (2020) , mentioned 3 main drivers of corporate digital transformation 1) digital personalization;
2) product servitization (a product as a service); 3) processes & structures changes (changes which increase employees' engagement, agility, move from traditional product competition to a competition model “customer as a service consumer", initiate innovation from within etc.). It could be noticed, that revealed drivers are well fit into TOE and DOI theories.

Theoretical academic background about key success factors of digital transformation is not very wide. Topic is quite new and very actual in today’s business world. Most popular frameworks and models about key success factors of digital transformation are Digital Maturity Model, Digital excellence model and Digital Readiness Model. Interesting fact is that all these models were developed by companies, but not by academic researchers.

Digital Maturity Model was created by Deloitte[10] and TM Forum and implies industry standard digital maturity assessment tool. Authors of the model aimed this tool to provide straight- line recommendations for companies on successful digital transformation. This model could help companies to understand at what stage of digital transformation they are now, what capabilities should be developed to pas next stage successfully and how to monitor the changes and their value, This model covers 5 main dimensions of capabilities which is necessary for a company to conduct

[10] Digital Maturity Model. Delloite, 2018. Access: https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Technology-Media-Telecommunications/deloitte-digital-maturity-model.pdf (date: (date:07.06.2020)

a successful digital transformation: customer, strategy, technology, operations and organization & culture. Customer dimension capability is about creation of such client experience in which clients perceive the company as a digital partner, with which they can interact through both offline and online channels for joint development. Strategy capability implies the ways of achievement competitive advantage through usage of digital innovations and consequent digital transformation. Technology dimension focuses on ability to collect, exchange and analyze data with the help of new technologies and digital solutions for fulfillment of customer's needs. Operations dimension focuses on the improvement of processes, increase of efficiency and effectiveness through application of digital technologies. Final dimension, organization & culture, implies creation of such corporate culture and such approaches to governance and talent managers, what will facilitate company to achieve innovation objective, increase digital readiness and support digital transformation. All these dimensions constitute 179 digital criteria which companies could use to assess their digital maturity and reveal success factors for the digital transformation.

Digital Excellence Model proposed by CIONET [11]community is really close the Delloitte model. As well as Digital Maturity Model it helps companies to define which capabilities are necessary for successful digital transformation, which of them are already developed and which should be developed. This model consists of five areas of capabilities. As well as Digital Maturity Model it includes customer dimension, strategic dimension, operational dimension and cultural dimension (named transformational capabilities in this model). The only "new" dimension is digital capabilities, which implies existence of digital competencies, skills and technological assets which is aligned to strategy and business model.

Digital Readiness Model [12]was developed by EY company. It not only explains which factors are essential for successful digital transformation of organization, but could also serve as an assessment tool. This tool provides a clear vision for a company about its current weaknesses and strengths in the digital context, stage of digital transformation and also allow to get an insight to industry and country specific difference. This model assesses seven dimensions and help to make a conclusion about current company's performance in each of them. According to this model, crucial seven pillars of digital transformation include such areas as: 1) Strategy, Innovation & Growth; 2) Customer Experience; 3) Supply Chain & Operations; 4) Technology; 5)Risk & Cyber

[11] Digital Excellence Model. CIONET, 2018. Access: https://cdn2.hubspot.net/hubfs/4295993/PL_Digital%20Excellence/DEA/Digital%20Excellence%20MODEL_EN.pdf?t=1540597166140 (date:07.06.2020)

[12] Digital Readiness Assessment. EY. Access: https://digitalreadiness.ey.com/ (date:07.06.2020)

Security; 6) Finance, Legal & Tax; 7)People & Organization. Relatively new dimensions in comparison with previous models mentioned, are issues of risk & cyber security and finance, legal & tax. Model considers digitalization of these areas to be the key for successful digital transformation.

Speaking about academic findings, most of the researches in the area of key success factors are empirical studies which are based on case studies. According to Osmundsen K. et al [4], main success factors of digital transformation mostly mentioned in researches are good management of transformation, engagement of management and employees, supportive corporate culture, improvement of IS capabilities, development of dynamic capabilities, digital business strategy and connection of business and IS. Mhlungu N. S. M., Chen J. Y. J., Alkema P. (2019) stated in their research that main groups of key success factors of DT are: customer centricity, governance, innovation and resource attainment. In addition, Verina and Titko (2019) conclude that significant factors are: company's strategy; orientation towards digital transformation; organizational culture; company's values; self-motivation of employees and readiness to accept changes. These factors are somehow included in all the models devoted to key success factors mentioned above.

1.4.1. Directions of future theoretical development

Even though several theories devoted to drivers and key success factors were already developed and some of them more than decades ago, there are still research gaps in existing studies as well as new unexpected findings which have initiated new researches. First of all, majority of studies about digital transformation are qualitative or empirical (which are mostly represented by qualitative case studies). Due to these, it's expected that future studies would become more quantitative or at least mixed (combination of quantitative and qualitative) [Reis J. et al.,2019] . These would result in more deeper understanding of relationships between factors affecting digital transformation and relationships between digital transformation and its outcomes. Moreover, empirical studies outweigh conceptual research. However, empirical qualitative case studies could be hardly generalized and therefore there is still a place of studies for generalization and conceptual research [Reis J. et al.,2019]. Opinion about the necessity of quantitative research devoted to factors affecting digital transformation is shared by various researches. For example, Liere-Netheler K. et al [12], suppose that even though most drivers of digital transformation were identified, there is still lack of quantitative or case study research, which can provide deep understanding of the effects and impacts of the drivers that were already detected. It is still not clear which factors are more significant and why. Therefore, future researches should provide not only the list and description of drivers but also their level of impact and interaction in relation to

adoption processes. Although demand for quantitative research devoted to the concrete impact of factors affecting digital transformation is quite obvious, there is still a room for investigation of theories and aspects which were already covered by various authors. Thus, for example, most of the theories about drivers of digital transformation are based on the models and frameworks, which were developed for other phenomena before the concepts of digitalization and digital transformation appeared. DOI and TOE theories were initially created for acceptance of innovation and new information technologies and only later were adjusted for an adoption of digital technologies. As most of new models and theories are based on the combination or enlargement of DOI and TOE, it could be concluded that there is still some areas and perspectives of digital transformation factors that were not fully covered [Ehie I. C., Chilton M. A., 2020]. The same could be stated about researches devoted to key success factors for digital transformation. Future research could deeper investigate these factors and their impact, main challenges and prerequisites for successful digital transformation [Reis J. et al., 2019].

1.5. Conclusion on chapter 1

This research will cover the gap what exist in current research. Review of literature and existed theory has shown that there is a need in further research in the area of factors affecting digital transformation of manufacturing companies. Currently, the majority of quantitative researches are based on the classical models (TOE, DOI) developed 15-20 years ago, which initially were developed to describe adoption of new technology in a company, but not Digital Transformation. Moreover, existing researches do not provide an insight on which factors are more significant specifically in manufacturing industry. It is necessary to understand how existent models and theories about factors affecting Digital Transformation would differ for manufacturing industry. According to Gillani, F., et all (Implementation of digital manufacturing technologies: Antecedents and consequences, 2020) there is an open question on identification of factors outside TOE theory (Technological, Organizational, Environmental context, classical theory), barriers and enablers of digital technology implementation that may impact the digitalization and consequent digital transformation in manufacturing. Moreover, entire research is focused on the developing market (Russia), therefore, resulted model could be further generalized for developing markets, as Russia could serve as a good base for analyzing emerging market specifics in the area of digital transformation of manufacturing. In addition, now the majority of researchers provide a rank of factors based on the opinion of interviewees or frequency of references of the entire factor by respondents. However, such an approach could be quite subjective in comparison with

quantitative, statistical estimation used in structural modeling. Finally, research will link findings about factors with digital transformation strategy in order to generate a practical value for a manufacturing business.

Analysis of digital transformation models and frameworks helped to define this phenomenon, understand its nature and consequences. Several models were selected for further investigation and decision about inclusion of presented factors in the research model. In the next chapter, factors would be analyzed in more detail from the perspective of appropriability for their testing and adding to the model. When, it would be necessary to define how exactly the model would be tested and analyzed as well as how primary data would be collected.

CHAPTER 2. DEVELOPMENT OF RESEARCH MODEL

This chapter is devoted to the finalization of research model. Firstly, the list of potential factors would be formulated using literature review. Then, based on literature review and semi-structured interview with expert in digital transformation of manufacturing companies, the final selection of factors would be conducted. Thirdly, hypothesis would be formulated with consequent proposition of research model. Furthermore, chapter would describe the chosen approaches for factors evaluation as well as strategical approach to sample formulation and data collection.

2.1. Development of research framework and research propositions

2.1.1. Factors overview

In order to construct a research model it's necessary to obtain a full picture of factors that could affect digital transformation of a company. This paragraph would provide in-depth analysis of factors affecting digital transformation mentioned in most citated and recent researches from reliable sources (Harvard Business Review, Elsevier, etc.). The main outcome of this paragraph is a full list of factors affecting digital transformation, which would be used for further selection for a research model.

Starting with traditional theories, factors from DOI model would be analyzed. As it was mentioned, in the chapter 1, it contains 3 groups of factors:

- Individual characteristics

In DOI model this group includes the only one factor: attitude towards change. This means the attitude of top management, main decision-makers and leaders of the company to the innovation. How ready these people to accept something new in operational life and if they have a tendency for innovation. The more positive the attitude to change of employees and management, the more likely company to initiate the adoption of new technologies and consequently digitally transform the business model[13]. In addition, positive attitude towards change also influence how smooth the digital transformation process would be. This factor mentioned not only in DOI Model. N.Verina, J.Titko[14] in their conceptual research on DT, Hartl E., Hess T[15] in their research devoted to role of

[13] Oliveira, T., & Fraga, M. (2011). Literature review of information technology adoption models at firm level.
[14] Verina, N., & Titko, J. (2019, May). Digital transformation: conceptual framework. In Proc. of the Int. Scientific Conference "Contemporary Issues in Business, Management and Economics Engineering'2019", Vilnius, Lithuania (pp. 9-10).
[15] Hartl, E., & Hess, T. (2017). The role of cultural values for digital transformation: Insights from a Delphi study.

cultural values in DI also mentioned attitude to change and positive perception of corporate innovations as a driver and suppurative factor of digital transformation.

- Internal organizational characteristics

This group includes several factors. First-level of company's formalization. Formalization implies the extent to which corporate operations and relationships are regulated by rules, procedures and code of conduct, as well as to what extent these formal procedures are written and pinpointed with documents. This factor is also mentioned in TOE model and other models which were based on DOI and TOE. For example, Chau and Tam[16] concluded in their research that more formalized companies more easily adopt new technologies because for successful digitalization development of regulations and rules of conduct is essential. Thus, companies which already heave well established procedures would require less time and overhead costs (and overall efforts) to do so. Second factor- centralization, i.e. the structure of dissemination of power and decision-making authority in the company. This factor also discussed in TOE model and outgrowths of DOI and TOE. Third factor - size of a company, which implies the quantity of employees. This factor was actively investigated in TOE and DOI models and researches of 2000-2010 years. Pan and Jang 2008[17], Zhu et al. 2003[18], Zhu and Kraemer 2006[19] – all them consider organizational size as a factor influencing DT. However, there is now one proven conclusion about positive or negative effect size have on DT. Zhu and Kraemer prove their hypothesis that large organizational size have negative impact on technology adoption due to interia and complexity of large structures. On the other hand, models- outgrowths of DOI and TOE model conclude that large firms have more available resources and slack which facilitate DT. Fourth factor in DOI model -organizational slack, the availability level of unaccounted resources in the company. DOI theory suppose that the more slack company has, the more the innovations disseminate in a company, especially at the adoption stage. Fifth internal factor is interconnectedness, the level of connectivity between parts of the corporate social system by interpersonal networks. This factors also discussed in TOE model and in research by Chau and Tam 1997 as a positive factor of DT. Final factor traditionally mentioned in DOI is overall organizational complexity, which implies complexity of corporate

[16] Chau, P. Y., & Tam, K. Y. (1997). Factors affecting the adoption of open systems: an exploratory study. MIS quarterly, 1-24.

[17]Pan, M. J., & Jang, W. Y. (2008). Determinants of the adoption of enterprise resource planning within the technology-organization-environment framework: Taiwan's communications industry. Journal of Computer information systems, 48(3), 94-102.

[18]Zhu, K., Kraemer, K., & Xu, S. (2003). Electronic business adoption by European firms: a cross-country assessment of the facilitators and inhibitors. European journal of information systems, 12(4), 251-268.

[19]Zhu, K., Dong, S., Xu, S. X., & Kraemer, K. L. (2006). Innovation diffusion in global contexts: determinants of post-adoption digital transformation of European companies. European journal of information systems, 15(6), 601-616.

infrastructure, the deepness and uniqueness of knowledge and skills possessed by company members. This factor could be negative because complexity become a barrier for adoption, but at the same time such complexity and barrier could be a motivation for company to search for ways of resolution through adoption of technologies[20].

- External organizational characteristics.

This group contains one main factor-system openness, which implies how corporate infrastructure (including technological infrastructure) and corporate business network is open for outside and interconnected. High openness consider to be a positive factor.

Next traditional model which was mentioned in chapter 1 is TOE (Technological, Organizational and Environmental context). According to it there are 3 main groups of factors:

- Technological factors

This group includes two factors. First - availability of new technology to the company. The more technologies are available for a company, the higher probability of digital transformation due to easier process of technologies adoption. In addition, companies surrounded by technologies (implementation by competitors, usage by consumers, accessibility on the market) more eager to adopt technologies in their operations. Liere-Netheler K at al.[21], in their research concluded that one of important factors affcetong digital transformation of manufacturing companies is innovative push (similar to technology availability in TOE). Development and adoption of technologies on the market stimulate all market players to also implement such technologies. Second technological factor- main characteristics of currently used technology (industry and company specifics, owned equipment etc.). Existent technological infrastructure affects how digital transformation process will go and what actions would be undertaken. Thong, J. Y. L. (1999)[22] concluded in his research that the more interconnected, compatible and less complex corporate technology is, the more positive effect on DT it will have.

- Organizational factors

This group is similar to "Internal organizational characteristics" group in DOI model. Main factors included in this group are size, organizational slack, formal & informal corporate structure (includes level of centralization and formalization), and communication processes.

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[20] Chau, P. Y., & Tam, K. Y. (1997). Factors affecting the adoption of open systems: an exploratory study. MIS quarterly, 1-24.

[21]Liere-Netheler, K., Vogelsang, K., & Packmohr, S. (2018). Drivers of digital transformation in manufacturing. In 51st Hawaii International Conference on System Sciences (HICSS), Waikoloa, Hawaii (2018) (pp. 3926-3935). Shidler College of Business.

[22]Thong, J. Y. (1999). An integrated model of information systems adoption in small businesses. Journal of management information systems, 15(4), 187-214.

- External factors

This group of factors could also be called environmental context, as it refers to main factors of macro and business environment of the company. It includes such factors as industry characteristics, market structure, rivalry level, technology support and infrastructure, and governmental factor. Industry characteristics discussed in many researches (Chau and Tam 1997; Oliveira and Martins 2009; Arvanitis and Hollenstein, 2001; F. Gillani. et al, 2020; Liere-Netheler K. et al; Berghaus, S. and Back, A. 2017 etc.). Industry specifics such as growth rate, development stage, level of uncertainty definitely affect digital transformation. From one hand, prosper and stable industry provides favorable conditions for any corporate change (including digital transformation). On the other hand, stability generates a sense of calm and unwillingness to change (since there is no need to), while instability and uncertainty force companies to undertake actions aimed at increase of flexibility, competitiveness and strength. And therefore, facilitate adoption of new technologies and digital transformation[23]. Rivalry in an industry also quite often mentioned in researches (Oliveira and Martins 2009; Pan and Jang 2008; Zhu and Kraemer 2006, Liere-Netheler K. et al; Thong 1999; Verhoef P. C. et al; Berghaus, S. and Back, A. 2017; Piccinini, E., et al 2015; F. Gillani. et al, 2020). Intensive competition stimulates companies to find ways to increase their competitiveness and keep the market share. Therefore, in the process of digital transformation competition serve as a motivator.

These 2 theories, TOE and DOI are progenitors and base for later theories and models, therefore most of the factors in existing researches are similar to them and could be grouped using mentioned separation.

In the research paper by Verhoef P. C. et al [24]. the main focus is on the external factors. Author mentioned that major drivers affecting digital transformation are digital technology, digital competition, digital customer behavior. Digital technology factor implies the rapidity of new technologies development, extension of technology variety and availability of new technologies to companies (close to technology availability factor mentioned above in TOE theory). Digital competition refers to the increase and shifts in competition between companies due to introduction of new technology, opportunity to obtain competitive advantage through technology and changing landscape due to digitalization. This changes forces digital transformation of all market players.

[23] Arvanitis, S., & Hollenstein, H. (2001). The determinants of the adoption of advanced manufacturing technology: an empirical analysis based on firm-level data for Swiss manufacturing. Economics of Innovation and New Technology, 10(5), 377-414.

[24] Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Dong, J. Q., Fabian, N., & Haenlein, M. (2021). Digital transformation: A multidisciplinary reflection and research agenda. Journal of Business Research, 122, 889-901.

Digital customer behavior implies changes in customer expectations, needs, customer journey and purchasing behavior resulted from world digitalization. As a result, companies have to adjust to these changes in consumers behavior by introducing new technologies (online sales and marketing channels, big data analytics, AI etc.). Factor of consumer behaviour also discussed by several authors (Schmidt, et al. 2017; Haffke et al 2017; Berghaus, S. and Back, 2017; G.Vial etc.) in the context of how consumer behavior affects DT and how it changes because of it.

In the Conceptual framework of digital transformation by G.Vial[25] also 3 factors are mentioned as main drivers of Digital Transformation. First, consumer behavior and expectations. Second, competitive landscape and the third - availability of data, that implies the opportunity to collect data with the help of digital technology that has a great potential to a business. Due to adoption of digital technology huge missives of data about production, operational processes, consumers and consumption could be generated. It leads to company's understanding of data value for the business and force more and more companies to introduce technologies which could collect and analyze such data.

One more comprehensive work about digital transformation is Conceptual model of digital transformation by Verina and Titko[26] which presents the developed by authors DT framework (presented in chapter 1) consisting of DT drivers, DT essence and DT results. Authors highlighted 9 driving factors (i.e. positive factors) of digital transformation: emergence of new markets and new business opportunities, development of e-business, increased competition, customer requirements and increased need (close to consumer behavior and expectation factors mentioned above), progress in technologies (innovative push/availability of technologies), digitization of tasks and processes, increased cooperation between old timers and digital natives, executive support and recognition of DT value by leaders (close to positive attitude factor). Even though authors have not grouped these factors, they fit into the division suggested in TOE and DOI models: external, internal, individual and technological.

Work by Liere-Netheler K., et al[27]. suggests following factors:

- Organizational

[25]Vial, G. (2019). Understanding digital transformation: A review and a research agenda. The Journal of Strategic Information Systems, 28(2), 118-144.

[26] Verina, N., & Titko, J. (2019, May). Digital transformation: conceptual framework. In Proc. of the Int. Scientific Conference "Contemporary Issues in Business, Management and Economics Engineering'2019", Vilnius, Lithuania (pp. 9-10).

[27] Liere-Netheler, K., Vogelsang, K., & Packmohr, S. (2018). Drivers of digital transformation in manufacturing. In 51st Hawaii International Conference on System Sciences (HICSS), Waikoloa, Hawaii (2018) (pp. 3926-3935). Shidler College of Business.

Under organizational factors author means factors which are controlled by the company. The strongest positive factors mentioned in this investigation are: Process & workplace improvement, vertical integration, horizontal integration, cost reduction management support. All factors except for management support show the expected benefits that digitalization and digital transformation could bring to a company. Management support means development of digital transformation vision and strategy which are aligned with overall business and corporate strategy.

- External

Under external factors the authors mean those aspects which are outside the company's direct control: customer demand, supply chain, innovation push, market pressure, laws and government. Customer demand implies both: growing volume of consumption and changes in customer needs (expectation of higher transparency, digitalization of product and purchase process, expected improvement and innovation etc.). Innovation push means availability of technologies in the industry, which are already adopted by competitors or/and promise success and significant benefits for a company. Market pressure implies growing competition, market saturation and decrease in margins which push company to look for new ways and opportunities. Laws and government factor means current changes in regulations, which establish positive conditions for technology introduction and digital shifts in companies. Under supply chain author understands the impact of constant interaction between suppliers, customers and all parts of supply chain on the need in digital technology. It could be noted that essence of these factors are similar to those which were already mentioned in theories above.

Other work by Osmundsen K.,[28] mentioned 4 main drivers of digital transformation: 1) Customer behaviour and expectations (this factor implies the same as customer demand factor suggested by Liere-Netheler K., et al and consumer behavior and expectations factor by G.Vial), 2) digital shifts in the industry which implies ongoing changes in the market caused by adoption of digital technology by industry players and resulted modification of processes and interactions (mix of 2 previously mentioned factors form other works: innovative push and competition); 3) Changing competition (same as Verhoef P. C., mentioned); 4) Regulatory changes (same as governmental factor in TOE model and work by Liere-Netheler K., et al)

All in all, it could be noted that there are approximately 33 main factors, which actively discussed in the digital transformation research field. Other factors are mostly made by combining or

[28] Osmundsen, K., Iden, J., & Bygstad, B. (2018, September). Digital Transformation: Drivers, Success Factors, and Implications. In MCIS (p. 37).

narrowing several of these factors. The following table represents summary of factors mentioned in most recent and cited researches:

Source: authors research

Table 1. *List of factors affecting DT of a company*

Author/ research	**Factor**
• DOI • TOE • Chau and Tam 1997	level of company's formalization and centralization
• DOI • TOE • Pan and Jang 2008 • Zhu et al. 2003 • Zhu and Kraemer 2006	company size
• DOI • TOE	slack
• DOI • TOE • Chau and Tam 1997	interconnectedness and communication process
• DOI • Chau and Tam 1997	complexity
• TOE • Liere-Netheler K. et al • Verhoef P. C. et al	Availability of technology/ Innovative push
• G.Vial, 2019	Availability of data
• TOE • Thong 1999	Specifics of technology (complexity, compatibility)
• DOI	System openness
• TOE • Chau and • Tam 1997) • Arvanitis and Hollenstein, 2001 • Oliveira and Martins 2009) • Liere-Netheler K. et al • Berghaus, S. and Back, A. 2017 • F. Gillani. et al, 2020	Industry & market specifics (industry pressure, uncertainty, condition)
• TOE • (Pan and Jang 2008	Governmental regulation (pressure/support)

• (Zhu and Kraemer 2005) • Liere-Netheler K. et al • Berghaus, S. and Back, A. 2017	
• TOE • Oliveira and Martins 2009) • (Pan and Jang 2008 • (Zhu and Kraemer 2005) • Liere-Netheler K. et al • (Thong 1999) • Verhoef P. C. et al. • Berghaus, S. and Back, A. 2017 • Piccinini, E., et al 2015 • F. Gillani. et al, 2020	Competition
• TOE	Technology support infrastructure
• Oliveira and Martins 2009	Technology readiness
• Oliveira and Martins 2009	Level of cyber security (Security applications)
• Pan and Jang 2008	Production and operations improvement (Expected benefits of DT)
• (Zhu and Kraemer 2005) • Verhoef P. C. et al.	technology competence.
• (Thong 1999)	CEO's innovativeness;
• (Thong 1999)	CEO's IS knowledge
• Verhoef P. C. et al. • Schmidt, et al. 2017 • Haffke et al 2017 • Berghaus, S. and Back, 2017 • G.Vial	Customer behavior
• Verhoef P. C. et al. • Liere-Netheler K. et al • Schmidt, et al. 2017 • Haffke et al 2017 • Berghaus, S. and Back, A. 2017	Customer expectations and demand
• Liere-Netheler K. et al	Expected benefits of DT

• Liere-Netheler K. et al • (Lee et al.2009)	Management support
• DOI • (Lee et al. 2009) • Hartl and Hess, 2017	Attitude towards change
• Liere-Netheler K. et al	Employee support
• Hartl, E. and Hess, T. 2017 • Haffke, I., et al 2017	Supportive corporate culture
• Horlacher, A., et al 2016 • Piccinini, E., et al 2015 • Mihailescu, M., et al 2016 • Petrikina, J., et al 2017	Managers and employees engagement
• Karimi, J. and Walter, Z. 2015 • Leischnig, A., 2017 • Berghaus, S. and Back, A., et al	Dynamic capabilities
• Verina N., Titko J., 2019	Cooperation with digital natives (digitally born firms)
• Yeow, A., 2017 et all 2017 • Nwankpa, J. K. et al 2016 • Schmidt, J., et al 2017 • Leischnig, A., et al 2017	Alignment of Business and IS
• Yeow, A., 2017 et all 2017 • Nwankpa, J. K. et al 2016 • Schmidt, J., et al 2017 • Leischnig, A., et al 2017	Development of digital business strategy
• Piccinini, E., et al 2015 • Hildebrandt, B., et al 2015 • Mueller, B. et al 2017 • Bilgeri, D., et al 2017	Leverage external and internal knowledge

Based on this list of 33 factors, the selection factors for research model would be conducted in next paragraph.

2.1.2. Selection of factors

This factor is devoted to the narrowing of list of factors and selection of 7-12 factors for a research model and further investigation.

To make research model more significant and characterized with high exploratory power it was decided to choose most significant factors, i.e. those which have strongest effect on digital transformation of company. In order to do so, mixed approach was used: combination of secondary data analysis (literature review of articles devoted to ranking of factors or/and estimation of their power) and primary data analysis. In order to collect primary data semi-structured interview with expert in digital transformation of manufacturing companies was chosen.

The semi-structured interview is based on the use of two types of questions: 1) mandatory, basic, which must be asked in any case; 2) Clarifying, which are used in the conversation or excluded from it by the interviewer, depending on the answers to the main questions. Thus, a certain variability of the survey is achieved, taking into account the individual characteristics of the respondents and changes in the communicative situation.

As an expert in digital transformation of manufacturing companies Timur Frolov was chosen. He is a Head of Digital Projects at Gazprom Neft, in Logistics, Processing and Sales unit. Taking into account the fact that Gazprom Neft is one of the leaders in Russia in Digital Transformation and significant experience of Timur (leading digital projects, participation in development of DT strategy for Gazprom Neft during several years), he was considered to be the most suitable candidate for the role of an expert in this research.

Interview consist of several obligatory questions:

1. How do you understand the expression "digital transformation" ?
2. What are the main drivers of digital transformation? In general, and specifically in your company?
3. What influences the process of digital transformation of the manufacturing company?
4. What are the main key factors for the success of DT in the company?
5. How would you rank the effect on DT of each of 33 factors from the list?

Based on the interview and literature review 33 factors determined in previous paragraph were ranked from 1 to 10, where 10 means strongest effect on DT. As a threshold score equaling 8 points was chosen (scores for each of factor is represented in Appendix 1). As a result 12 factors was selected as most significant according to expert: 1) Availability of technology/ Innovative push, 2) Attitude towards change; 3) Competition; 4) Customer expectations and demand; 5) Customer behavior; 6) Expected benefits of DT; 7) Management support; 8) Employee support; 9) Alignment of Business and IS; 10) Interconnectedness (of corporate technologies); 11) Industry & market specifics, 12) specifics of corporate technology. This result confirmed most of the

insights about strongest factors obtained from literature review. Therefore, it was decided that there is no a need in interviews with other experts, as there were no any controversial and doubtful results.

Further, these factors were renamed and some of them were grouped in order to structure the research model make it more reader-friendly:

source: compiled by the author

Table 2. *Factors selected for further in-depth research*

Initial factor name	Proposed factor name	Meaning in entire research
Availability of technology/ Innovative push	Innovative push	the presence of innovative technologies in the industry that have already been adopted by competitors or / and promise success and significant benefits for the company
-Attitude towards change -Expected benefits of DT -Management support of DT -Employee support of DT	Attitude to DT and change	Attitude to changes and DT (by top management, personnel): perception, resistance level.
Competition	Competition	The level of competition on a market where company operates
-Customer digital expectations and demand -Customer behavior	Responsiveness to customer needs and expectations	Factor, showing to what level company adjust to customer behavior, needs and expectations
-Interconnectedness (of corporate IS) -Specifics of corporate technology	Corporate technology	The specificity of current information systems used in a company from the perspective of its complexity, compatibility and interconnectedness
Industry & market specifics	Market condition	The current condition of the market where company operates (level of prosperity & stability)
Alignment of Business and IS	Alignment of Business and IS	To what extent do the company's information systems usage correspond to the business goals and strategy

Based on these factors research hypotheses would be formulated and research model would be constructed.

2.2. Proposition of research model

This paragraph is devoted to justification of modeling approach choice, development of hypotheses and proposition of research model.

2.2.1. Structural Equation Modeling

Modeling is a well-known approach in research and analysis. It helps to investigate various phenomena on the base of a model (smaller, controlled version of research object). This entire research is based on the Structural Equation Modeling (SEM). SEM is a multivariate analysis method for evaluating causal relationships, combining a range of statistical tools (regression analysis, path analysis and factor analysis)[29]. The important feature and the reason for choosing SEM for this research, is that Structural Equation Modeling could estimate unobservable hidden structures and abstract phenomena, i.e. latent variables. Latent variable is such a variable that could not be measured directly in comparison with observed variables (for example height, blood pressure, income etc.). Good examples of latent variables are factors affecting digital transformation of a company. None of the selected factors in the previous paragraph could be estimated directly, because all of them represent some abstract phenomena, however they could be measured by indirect signs with subsequent analysis. In order to estimate latent variables and relationships between them, Structural Equation Modeling uses measurement and analysis models that define latent variables with one or more observable variables, as well as a structural model that includes paths and relationships between latent variables. The relationships between the structural constructs that result from the SEM and the empirical data can be estimated by independent regression equations[30].

In this type of structural modeling, there are two main elements: structural model and measurement model. Measurement model estimates relations between latent variables and their indicators (items), i.e. it estimates the composition of factors. Structural model measures causal relationships between endogenous (dependent) and exogenous variables (independent variables, which influence latent variables in a model), i.e. it measures the influence of factors on each other and on the main phenomena.

[29] Ожерельева, Т. А. (2017). Уравнения структурного моделирования. Перспективы науки и образования, (2 (26)).

[30] Janssens, W., De Pelsmacker, P., Wijnen, K., & Van Kenhove, P. (2008). Marketing research with SPSS. Pearson Education.

In this entire research 5 types of analysis are planned to be implemented with the help of SEM: path analysis, exploratory factor analysis (EFA), confirmatory factor analysis (CFA), mediating effect analysis and moderating effect analysis.

- Path analysis

This analysis implies a multivariate method that is based on linear regression. This allows to estimate the strength of the direct impact of one structure on another, as well as the indirect impact through intermediate structures in a pre-defined model. The main outcome of this analysis in entire research would be path diagram, represented in a linear form $Y=bX+e$, where Y-dependent latent variable (Digital Transformation), X (independent latent variable, factor influencing DT), e - error variance, b - regression coefficient (the level of change in independent variable (DT) for each 1 unit of change in the dependent variable (factor)). Path analysis would help to understand the strength and nature (positive/negative) of effect of each factor on digital transformation.

- EFA

Exploratory factor analysis is an investigating technique, which helps to understand how and to what extent are the observed items related to the underlying latent constructs. The main outcome of EFA would be understanding and conclusion on factor contents: which items are related to factor 1, which items are related to factor 2 etc. This will either confirm the proposed structure of factors, either lead to necessary changes in it. All in all, EFA would help to finalize the latent variable structure. It's necessary because the estimation scale of most of the factors would be developed by the author of this dissertation in the further paragraph, and these scales require additional testing and investigation from the perspective of their validity and reliability.

- CFA

Confirmatory factor analysis tests the hypothesis that there is a relationship between item and underlying latent construct. This analysis is applied when latent variables structure is already defined and tested in order to confirm the structure. Moreover, CFA is used for confirmation of overall model structure (influence of latent variable on each other and/or their influence on research subject). In this dissertation, the main outcome of CFA would be confirmation of the model structure, resulting from the model adjustments and improvements during the EFA step.
In addition, the overall goodness of the model would be estimated. It will show whether the model significant and whether it has high explanatory power. In order to estimate goodness of fit, several coefficients would be used[31]:

[31]Janssens, W., De Pelsmacker, P., Wijnen, K., & Van Kenhove, P. (2008). Marketing research with SPSS. Pearson Education.

1. Goodness of fit index (GFI)- it shows the proportion of variance accounted for by the estimated population covariance. It shows the overall explanatory power of the model, the closer it to 1 the higher the explanatory power. The required threshold for this coefficient is 0,9.
2. Chi-square (χ^2)- it evaluates the overall fit and discrepancy between the sample and the matched covariance matrices, by checking the null hypothesis: "The model fit is absolute". Could be sensitive to the number of observations in test sample. Reference value: p-value> 0.05
3. Tucker-Lewes index (TLI) (also could be called NFI – Normed Fit Index)- it shows the discrepancy between the χ^2 of the hypothetical model and the χ^2 of the null model. Recommended threshold is 0,9 or 0, 95.
4. Comparative fit index (CFI)- compares the fit of a target model to the fit of a null model. Not very sensitive to the number of observations in test sample. Recommended threshold is 0,9.
5. Root Mean Square Error of Approximation (RMSEA)- is an absolute fit index. It shows the extent to how far a hypothetical model is from an ideal model. The closer this coefficient to 0, the better the model. Threshold is RMSEA < 0.08

- Mediating and moderating effect analysis

This type of analysis would be used in order to define if any of tested latent variables from the research model serve as a moderator for other latent constructs and research subject. i.e. whether there are mediating variables, which conveys the influence of the other independent variables on the dependent variable. Moderating effect analysis helps to check whether there is a variable-moderator, which affects the strength and orientation (positive/ negative) of relationship between some other dependent variable and independent variable. These analyses could reveal implicit relationships between research variables and deepen the entire investigation.

Structural equation modeling has several advantages[32]. As it was mentioned earlier, this approach was chosen because it allows to estimate unobservable hidden structures and abstract phenomena, i.e. latent variables. But in comparison with other approaches to measure relationships between latent variables (principal components analysis (PCA), partial least squares (PLS) and etc.), which

[32] Lahey, B. B., McNealy, K., Knodt, A., Zald, D. H., Sporns, O., Manuck, S. B., ... & Hariri, A. R. (2012). Using confirmatory factor analysis to measure contemporaneous activation of defined neuronal networks in functional magnetic resonance imaging. Neuroimage, 60(4), 1982-1991.

are mostly exploratory and do not aimed directly at testing of alternative hypothesis, SEM and CFA are confirmatory approaches. It could be used to statistically check numerous hypotheses in a model. Furthermore, important feature of Structural Equation Modeling is that it estimates the relationships between latent variables simultaneously at one time and evaluate all model as a whole. SEM estimates simulationsly not just direct relationships (which other approaches also could do), but also complex, cumbersome structured models (with mediation, moderation check, grouping, etc.). Moreover, Confirmatory Factor Analysis used in SEM provide enough detailization of source of problems in a model, in cases when goodness of fit appeared to be bad. Therefore, researches are able to undertake necessary corrections and make right conclusion for further improvement of a model. In addition, CFA analyzes error variance separately from the unexplained variance in the underlying constructs.

However, this approach also has some limitations[33]. To start with, evaluation of latent constructs is sensitive to subjectivity. Though, this limitation is not mostly about SEM, but about latent variables. As they are abstract and could not be observed directly, question of erroneous estimates always exists. This risk could be decreased by using already tested evaluation techniques or with the help or preliminary exploratory analysis of measurement model. Other limitation of SEM is that it requires large sample size. Moreover, in SEM the number of estimated parameters cannot be higher than the number of known values.

All in all, regardless its limitation, Structural Equation Modeling has a best fit for such type of a research, where structural model, consisted of latent variables, should be tested.

2.2.2. Hypotheses and research model

Seven factors were selected in paragraph 2.1.2. for further research. In order to construct a research model, seven hypotheses were formulated:

H1: *High competition in an industry, where company operates positively impacts Digital Transformation of entire company*

The influence of competition on company's different areas of performance and operations always was under great attention. As it was mentioned in previous paragraphs, many authors consider copatition as an important factor affection Digital Transformation. Intensive competition

[33] Werner C., Schermelleh-Engel K. Structural equation modeling: Advantages, challenges, and problems [online resource] //Introduction to Structural Equation Modeling with LISREL. – 2009. – Access: http://kharazmi statistics.ir/Uploads/Public/MY%20article/Structural%20Equation%20Modeling.pdf (date:14.02.2021)

stimulates companies to find ways to increase their competitiveness and keep the market share. Therefore, in the process of digital transformation competition serve as a motivator (Oliveira and Martins 2009; Pan and Jang 2008; Zhu and Kraemer 2006, Liere-Netheler K. et al; Thong 1999; Verhoef P. C. et al; Berghaus, S. and Back, A. 2017; Piccinini, E., et al 2015; F. Gillani. et al, 2020).

According to Porter (2001), the volatile demand and growing rivalry result in a threat of product substitution, which motivate market players to adopt new technologies that aid the efficient production of new products. Companies tend to implement digital planning, design, and production systems which could increase efficiency and accuracy of the production process. The communication technologies assist in maintenance of real-time connectivity with customers and other functional departments, allowing unimpeded and error-free execution of the manufacturing process. Hence, the more the competitive rivalry and threat of product substitution, the more the firms will focus on new technology adoption and bring changes to sustain profitability (Porter, 2008)

H2: *High innovative pressure and availability of technologies in an industry, where company operates positively impacts Digital Transformation of entire company*

The existence and implementation of digital manufacturing technologies are possible due to information and communication technologies (ICTs) and AMTs (Brettel et al., 2014; Yu et al., 2015). Nowadays, there are a plenty of new technologies which could be implemented in manufacturing: real-time tracking and data transmission by radio-frequency identification (RFID), three-dimensional (3D) printing, precision technologies, adaptive manufacturing systems, automated processes and robotics (Brettel et al., 2014; Strozzi et al., 2017; Dalenogare et al., 2018). RFID is used for tracking and tracing of products and manufacturing objects and collecting data in real-time for production (Strozzi et al., 2017). Digital manufacturing uses high precision technologies such as 3D printers, laser cutting, and water cutting (Dalenogare et al., 2018). Along with these manufacturing technologies, process automation and robotics are also an integral component of the digital manufacturing landscape. Process automation and the use of automated guided vehicles is not a new concept. However, the digital and reconfigurable nature of advanced technologies makes it easier for firms to switch to automation and use such vehicles at the shop floor level for efficient and seamless operations. Availability of such beneficial and promising solutions attracts companies and motivate them for digitalization of their business process (F. Gillani. et al, 2020). Moreover, the more market players introduce such technological

solutions in their business activities, the less choice are left for other market players. In order to stay competitive and not lag behind rivals, all market players would consequently refer to digital technology, business transformation and development of digital capabilities. Based on the fact of changing consumer behavior, needs and expectations due to digital revolution, it could be concluded that companies, which are more responsive to consumers and more costumer oriented would be more actively initiate digitalization of their business process. In addition, taking into account benefits and opportunities generated by digital technologies in the area of consumer expectations analysis and adjustments, it could be concluded that more customer-oriented enterprises would be more likely to implement such technologies and consequently digitally transform their business models.

H3: *Alignment of business and Information Systems in an enterprise, positively impacts Digital Transformation of entire company*

Alignment of business and IS implies such situation in a business life of a company when it effectively uses information technologies and systems for achievement of overall business goals. One of the biggest problems in organizations is the misalignment between business and IT objectives and needs. Because each of these domains works independently for their improvement through individual frameworks, the result is failed projects and delays in overall company performance. So, the more aligned the business and information systems are, the less separate from the main business IT function stays. Some companies have confirmed that there is a need to unite business strategy and IS strategy in order to formulated digital strategy, which will support an organization in realization and achievement of the objectives of digital transformation, by emphasizing digital leadership abilities, agile and scalable digital operations, digitally enabled customer experiences, and emerging digital innovations (K.Osmundsen, et al., 2018). In a Digital Excellence Model proposed by CIONET alignment of business and IS represented as sign of digital maturity. Alignment of technological assets to strategy and business model is a part of digital capabilities which are necessary for successful digital transformation.

H4: *Positive attitude to change and digital transformation in an enterprise, positively impacts Digital Transformation of entire company*

Attitude towards change means the attitude of top management, main decision-makers and leaders of the company to the innovation. How ready these people to accept something new in operational

life and if they have a tendency for innovation. Most experts agreed that digital transformation implementation mainly depends on the corporate message to the company's employees, as well as on employees' willingness to change and their internal resistance or readiness for transformation processes (N.Verina, J.Titko, 2019). Companies with negative attitude to change face a serious barrier to digital transformation- resistance (G.Vial, 2019). Resistance from the side of employees, who could not be ready for upcoming innovations, could result in taking actions that slow down changes and undermine overall perception of digital transformation.

H5: *Generalized and interconnected technology applied in an enterprise, positively impact Digital Transformation of entire company*

According to G.Vial et al., and his research devoted to development of conceptual framework of digital transformation one of the barriers for successful digital transformation is interia. It implies the situation when existing resources (tangible and intangible) discourage digital transformation. This also the case when company has adopted very specific and nontraditional technologies, which could be hardly united and integrated with each other and with other digital technologies due to compatibility problem. It could be concluded that companies which has more generalized and widely spread technologies could more easily execute digital transformation steps. Interconnectedness of technologies in an enterprise is also an important factor which has impact on DT. Firms that are integrated are more responsive to changes (Hofmann and Rüsch, 2017; Battaïa et al.,2018). Interconnected systems help to collect, store, and transmit data about the products, production processes and their environment. This data could facilitate and support changes in a company, by providing deep insights of current performance and allowing proactivity.

H6: *Instabilities in an industry, where company operates positively impacts Digital Transformation of entire company*

As well as high rivalry, rapidly changing and unstable market force companies to adapt to these volatilities in order to survive and keep profits. In comparison with companies operating under condition of stability, such firms should be more proactive and flexible (F. Gillani. et al, 2020). In order to achieve this, companies use different tools and approaches, including implementation of digital technologies and transformation of business models. With the help of digital technologies companies could create connected and open corporate communication network.

Firms that are integrated are more responsive to changes in the external environment and towards customer demands (Hofmann and Rüsch, 2017; Battaïa et al.,2018). Firms operating in a rapidly growing or declining market, or those operating in industries with frequent changes and advances in technology, also constantly need to modernize in order to maintain their market share and remain competitive (Arvanitis and Hollenstein, 2001). Enterprises which could effectively use digital technology and have a capability of tracking and analyzing changes in the market, have an advantage. They cope with these changes in a timely manner and maintaining their competitiveness (Dosi et al., 1994).

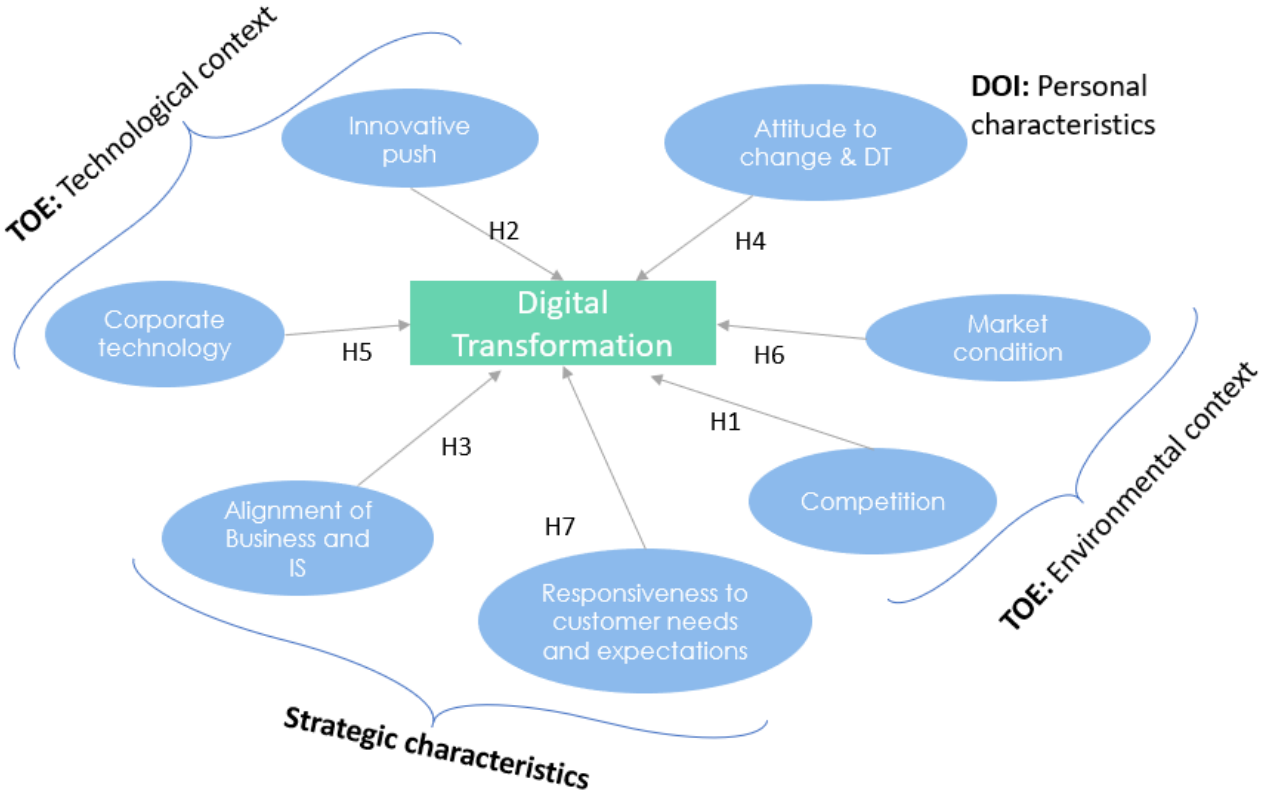
H7: *High responsiveness of an enterprise to customer needs and expectations positively impact Digital Transformation of entire company*

In order to create a value for consumer and consequently generate profits, increase loyalty and brand image companies strive to satisfy customer needs, predict their expectations and adjust to costumer's behavior. These are the basics of leading business. Nowadays, consumer behavior is changing as a response to the digital revolution. Market figures show that consumers are shifting their purchases to online stores, and digital touchpoints have an important role in the customer journey affecting both online and offline sales (Kannan & Li, 2017). With the help of new search and social media tools, consumers have become more connected, informed, empowered, and active (e.g., Lamberton & Stephen, 2016; Verhoef et al., 2017). Digital technologies allow consumers to co-create value by designing and customizing products and perform last-mile distribution activities (Beckers, van Doorn, & Verhoef, 2018; Grönroos & Voima, 2013). These new digital technologies are likely to structurally change consumer behavior (cf. Hoffman & Novak, 2017; Verhoef et al., 2017), and, consequently, the digital technologies implementation become the new norm and challenge traditional business rules. If firms cannot adapt to these changes, they become less attractive to customers, and are likely to be replaced by firms that do leverage such technologies.

Model

Based on these hypotheses following research model was formulated:

source: compiled by the author

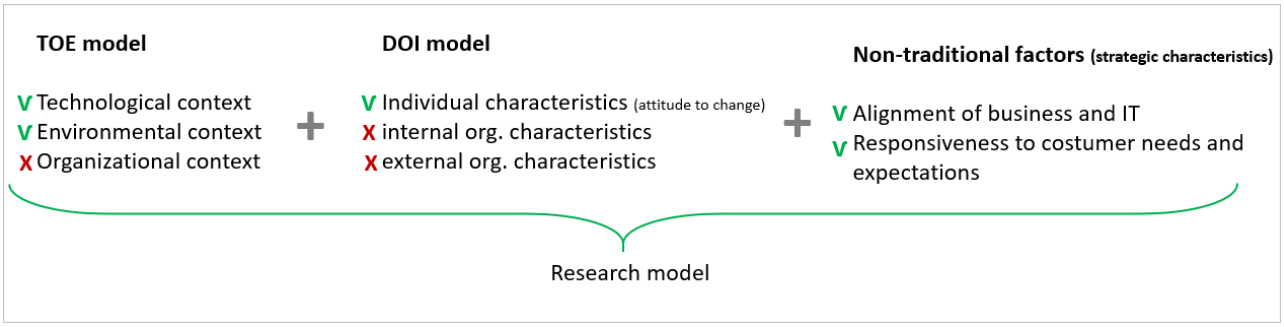


Pic 5. *Visualization of research model*

This is the structural model which will be used in SEM analysis in order to test research hypotheses.

It could be noted that proposed model is a mixture of traditional theories TOE and DOI but with addition of 2 new, more strategically oriented factors:

source: compiled by the author



Pic 6. *Connection of research model with previous research*

Organizational characteristics/context mentioned in TOE and DOI appeared to be less significant than other factors by results of interview with expert and literature review.

To sum up, a model with seven factors potentially affecting digital transformation was developed. It will be further used for quantitative analysis.

2.3. Research Design Development

This paragraph is devoted to the choice of factors evaluation approach as well as to development of a questionnaire, which is necessary for primary data collection. As the variables, which I will test in a model, all latent (not observable), it's crucial to find right approach for their estimation.

2.3.1. Choice of technique for DT and affecting factors assessment

Structural Equation Modeling was chosen in previous paragraph as a method for structural modeling in entire research. Primary data would be collected for model test. In order to collect primary data, survey would be conducted. Survey is well suited for quantitative research because it allows to collect standardized data, in appropriate format for statistical testing. Moreover, it is a good way to collect necessary data about latent variables[34]. Most popular approach for estimation of latent constructs through questionnaire is application of Likert ranking scales. The summary score scale created by Likert is a psychometric measurement that is often used in the formation of questionnaires or questionnaires. When working with it, the respondent evaluates the level of agreement with the above judgments, or vice versa. The approximate structure of the scale consists of five elements (ratings):

- Fully agree
- Partly agree
- Difficult to answer
- Partly disagree
- Fully disagree

The main advantages of Rensis Likert system are: ease of understanding and collecting information; easy data processing; and relative reliability. As for the shortcomings, there are several of them: avoiding extreme (tendency to average values) and average (striving for polarity) assessments; rash agreement or disagreement with statements; the desire to make a good impression, which leads to insincerity of answers.

The reliability of the scale for the study depends on the careful selection of statements which will be provided for respondents. Therefore, it is important to analyze DT and each affecting factor

[34] Janssens, W., De Pelsmacker, P., Wijnen, K., & Van Kenhove, P. (2008). Marketing research with SPSS. Pearson Education.

from research model from the perspective of its contents and subparts. Full understanding of factor content is essential for development of questions, which will estimate DT and each factor.

- Digital Transformation

As the topic of DT is very popular and important for strong market players, many researches and especially consulting companies strives to develop mechanisms to estimate level of DT in a company. Bain & Company's developed their survey- Digital Readiness Assessment, for companies who want to assess their level of DT. This survey estimates companies from 10 perspectives: 1) digital strategy; 2) Costumer and service engagement; 3) Digital products and services; 4) Economic model; 5) Operations; 6) Data and analytics; 7) IS and technology; 8) Operating model and network; 9) Culture; 10) Orchestration. One more questionnaire, Digital Transformation Readiness Assessment, was proposed by SCOPISM[35]. It's quite similar with Bain & Company's survey, but with addition of automation level perspective (higher focus, than in Bain's assessment). Therefore, it would be a good idea to use mixture of this questionnaires.

- Competition

The most famous works about competition was written by M. Porter[36]. He provides depth insights on what influences the competition, what does it consist of. According to 5 competitive forces framework by porter, there are 5 main dimensions of competition: overall rivalry, power of suppliers, power of buyers, threat of substitutes and threat of new entrants. In order to evaluate overall rivalry is important to get insights on the level of competition in the market where the company is represented, market saturation, number of market players, size/strength of competitors, diversity of competitors, product differentiation, switching costs, customer loyalty.

- Innovative push

In TOE theory innovative push implies technology availability that means that there are new digital technologies which could be implemented in production, sales/distribution, marketing or other activities of a company and which are now available for the company (in terms of financial resources, compatibility and access). Moreover, innovative pressure implies pressure from competitors who already actively implement new technologies in order to increase their competitiveness. Gradually, it become impossible to keep competitiveness ability realize full potential without the digital technology for other market players. To summarize, main components

[35] Digital Transformation Readiness Assessment. Scopism. Access: https://www.scopism.com/questionnaires/digital-transformation-readiness-assessment/ (date: 16.02.2021)

[36] Michael E. Porter. "How Competitive Forces Shape Strategy". Harvard Business Review, 1979. Access: https://hbr.org/1979/03/how-competitive-forces-shape-strategy (date: 10.03.2021)

of innovative push are presence of digital technologies which available for the company, pressure from competitors and intention to keep competitiveness.

- Attitude to DT and change

Attitude to change is quite popular topic in corporate psychology and therefor there are quite many existing survey scales developed in order to estimate it. In the work by Neiva E. R. et al[37] aimed at validation of scale for estimation of attitude to change in organizations through exploratory factor analysis on random sample consisted of 286 employees from Company A and 128 employees from company B. Companies are absolutely different in terms of culture and structure. As a result of these research, 3 main factors which constitute attitude to organizational change were confirmed. First, is the belief in the realization of change i.e. do employees believe that the change will actually happen. In companies where employees undertake measures to slow change and where changes stop at the stage of discussion, this believe is low. Second aspect, is a fear of loss (of salary, job position) because of a change. It reflects the negative perception of change due to uncertainty which it brings. Third aspect is about perceived benefits of organizational change. Do employees believe that the change will benefit organization and each employee personally. Whether they consider changes useful or not. Shortened, adjusted version of scale proposed by Neiva E. R. et al would be used in entire research. In order to include attitude specifically to DT aspects of management support and employee support of DT would be also tested.

- Responsiveness to customer needs and expectations

This factor could be also called costumer orientation. It implies the situation when companies set customer satisfaction and responsiveness to their needs a priority. In a work by Smirnova, M. M., Rebiazina, V. A., & Frösén, J.[38] main aspects of costumer orientation which are tested through MKTOR scale by Narver and Slater (1990) in a survey are: alignment of consumer needs satisfaction with business objectives, regular investigation of costumer needs as well as level to their responsiveness, understanding of needs, post sale service and support and regular satisfaction estimation.

- Corporate technology

Corporate technology shows specificity of current information systems used in a company from the perspective of its complexity, compatibility and interconnectedness[39]. Interconnectedness is

[37] Neiva, E. R., Ros, M., & Paz, M. G. T. (2005). Attitudes towards organizational change: validation of a scale. Psychology in Spain, 9(1), 81-90.

[38]Smirnova, M. M., Rebiazina, V. A., & Frösén, J. (2018). Customer orientation as a multidimensional construct: Evidence from the Russian markets. Journal of Business Research, 86, 457-467.

[39] Thong, J. Y. (1999). An integrated model of information systems adoption in small businesses. Journal of management information systems, 15(4), 187-214.

evaluated as a degree to which corporate systems represent one, well organized network rather than separate systems. Compatibility of IS is the ability of information systems and other digital solutions to work together without being modified to do so[40]. Compatible systems work with the same data formats or able to automatically convert it needed formats. Usually, most popular systems are more compatible (Like SAP ERP, Oracle etc.). Complexity implies the extent to which corporate systems are difficult to use, how often they bagging and etc. These characteristics of corporate technology would be examined in a questionnaire.

- Market condition

For the purpose of testing the hypothesis number 6, it would be necessary estimate market condition from the perspective of its stability. Market stability constitute of several aspects. First, Level of volatility[41] (i.e. how much market dynamics is changing in a short period of time, the more it changes, the higher its volatility). Second, degree of uncertainty, which implies impossibility to define probability of outcomes of events in the industry. The more the uncertainty, the lower the stability of an industry (TOE, 1996). According to theories about Industry Life Cycle (M. Porter, 1980) industries which are at the stages of growth or decline are less stable, while industries at the maturity stages are stable. Therefore, question about industry maturity stage would be also useful.

- Alignment of Business and IS

Alignment of business and IS implies to what extent do the company's information systems usage correspond to the business goals and strategy. In order to estimate it, mix of existing tools would be used. Strategic Alignment Maturity Model proposed by Luftman in 2004 covers 6 main areas of business and IS alignment maturity. First is the communication maturity between IT function and others, which implies freedom of communication between IT department and others, cross sharing of knowledge, understanding of business by IT and IT by business. Second is value measurement maturity which shows how company estimate and understand the value IT generates for overall business. Third – governance maturity implies the compliance and right choice of participants accountable for planning and management of IT resources. Fourth is partnership maturity which is about relationships between IT and other functions: whether they trust each other, share risks and wins. Fifth aspect is scope and architecture maturity. It reflects the flexibility and transparency generated by IT for a company' operations. Last, sixth aspect, is skills maturity

[40] Vial, G. (2019). Understanding digital transformation: A review and a research agenda. The Journal of Strategic Information Systems, 28(2), 118-144.

[41] Gillani, F., Chatha, K. A., Jajja, M. S. S., & Farooq, S. (2020). Implementation of digital manufacturing technologies: Antecedents and consequences. International Journal of Production Economics, 229, 107748.

that is about level of innovativeness, readiness to change and their contribution for corporate goals achievement. Bourdeau S., et all[42] also outline the importance on identification whether company has IS strategy or not and whether business strategy of a company is relied on/ involved IT and corporate information systems.

2.3.2. Questionnaire development and data collection

Previous paragraph stressed main theories and existed scales that would serve as a base foe questionnaire development. Following table provides the summary on scales composition approach (existing scale – previously developed and tested scale by other researches, original scale baed on theory - scale developed by author of entire research based on the related theories):

source: compiled by the author

Table 3. *Summary table of scales development methodology for questionnaire*

Likert Scales development for questionnaire		
Latent Variable	**Approach**	**Theory base for questionnaire**
Digital transformation	Existing scale	-Bain & Company's Digital Readiness Assessment
Competition	Original scale based on theory	M. Porter, 1979
Market condition	Original scale based on theory	-TOE, E. Rogers 1996 -F. Gillani. et al, 2020 - M. Porter, 1979
Costumer orientation (Responsiveness to customer needs and expectations)	Existing scale (adjusted)	MKTOR scale by Narver and Slater, 1990
Alignment of business and IT	Original scale based on theory	-Strategic Alignment Maturity Model, Luftman in 2004 - Bourdeau S., Hadaya P., Lussier J. E., 2018
Attitude to change and DT	Existing scales modified with the help of an expert interview	Neiva E. R. et al, 2005
Corporate technology	original scale based on theory	-Thong, J. Y. L., 1999. -G.Vial et al., 2019

[42] Bourdeau, S., Hadaya, P., & Lussier, J. E. (2018). Assessing the Strategic Alignment of Information Systems Projects: A Design Science Approach. Projectics/Proyectica/Projectique, (2), 115-154.

Innovative push	original scale based on theory	-TOE, E. Rogers 1996 -F. Gillani. et al, 2020

As a result, questionnaire with 9 sections and 58 questions were developed:

Section 1. Information about the company and respondent:

1. The industrial sector that the company you work for belongs to
2. Size of the company
3. Location of the company
4. Department there do you work
5. Your relation to digital transformation (direct: realization; indirect: affected by DT; none)

Section 2. Measuring the level of digital transformation in the respondent's company.

6. Our company has a clear vision of how we will succeed in the digital future, and we are taking the necessary steps to achieve this vision
7. We have the right people, skills, and culture to realize our digital vision
8. We use digital technologies to improve and differentiate our products, services, and customization
9. We have implemented digital technologies in most aspects of our business
10. Business process automation capabilities are regularly identified, evaluated, and implemented
11. We use new technologies such as artificial intelligence, big data, and robotic process automation
12. Our company evaluates and accepts new methods of organizing the workflow (for example, Agile, Lean)
13. The development and implementation of digital initiatives involves not only representatives of IT, but also representatives of other functions
14. We actively use data and analytics to make decisions
15. We regularly identify major gaps in our company's digital capabilities and develop plans to address them
16. Our company successfully transforms digital initiatives from experiments into large-scale projects (including aggressive funding of key initiatives)

Section 3. Measurement of innovative push in the industry to which the respondent's company belongs.

17. There are many digital technologies available to our company that can be applied in our industry in the production / sales and distribution process

18. There are many digital technologies available to our company that can be applied in our industry in marketing communications
19. There are many digital technologies available to our company that could be applied in our working (office) life
20. Our main competitors are actively using digital technologies
21. Our company strives to be a leader and stay ahead of the competition in the use of digital technologies

Section 4. Assessment of the respondent company's attitude to digital transformation and changes in general

22. In our company, the idea of Digital Transformation is supported by the management
23. In our company, the idea of Digital transformation is supported by employees
24. In our company, people DO NOT develop mechanisms and workarounds to avoid change
25. Changes in our company do not stop only at the level of discussions: they actually happen
26. Inevitable changes in our company do not cause fear and dissatisfaction in people
27. We believe that changes in our company are useful because they can "breathe life" into this organization
28. Changes in our company are important because they benefit employees

Section 5. Measuring the level of competition in the industry to which the respondent's company belongs.

29. Our company belongs to a highly competitive market
30. There are many active companies in our industry
31. The market is represented by a lot of large and strong players
32. The products created by companies in our industry are not very diverse
33. In our industry, consumers do not have high costs when switching from one brand to another

Section 6. Measuring the degree of customer orientation in the company where the respondent works

34. We strive to create value for our customers
35. We understand the needs of our customers
36. Our company always strives to meet the needs and expectations of the consumer
37. We have differentiated offers and products for different segments of consumers
38. We regularly measure customer satisfaction
39. We closely monitor the after-sales customer service

Section 7. Assessment of corporate information systems and technologies in the respondent's company

40. The information systems, applications and software used in our company form a single corporate network (i.e. they are all connected to each other)
41. The information systems, applications and software used in our company work well
42. Information systems, applications and software used in our company are not unique (i.e. common in the market of SAP, 1C, Oracle, etc)
43. In our company, information systems are specially developed by the company's specialists (or third-party organizations) in accordance with the company's needs

Section 8. Assessment of the state of the industry to which the respondent's company belongs

44. Our industry is characterized with unstable profitability and high risks
45. The level of uncertainty in our industry is high
46. Our industry is unstable and volatile
47. Our industry is at the stage active growth or decline
48. Our industry is not supported by the state

Section 9. Measuring business and information system alignment.

49. In our company, representatives of the IT department could easily come to the management with innovative ideas
50. In our company, information systems and IT create great value for business
51. In our company, the planning of IT resources (financial, human, material, assets, intangible, etc.) is carried out with the joint participation of management and IT representatives
52. In our company, the management understands the basics of IT
53. In our company, the IT department understands the basics of business
54. In our company, employees trust the IT department
55. In our company, IT employees actively communicate with other functions
56. Our company has an IT strategy
57. Information systems and IT — one of the components of our business strategy

58.Optional Question: name of the company

Target Sample:

In order to obtain representative sample, it was necessary to disseminate questionnaire among right target audience. As the research is about manufacturing companies it’s necessary to survey employees (or owners, or ex-employees) of manufacturing companies. Second requirement for respondent is working experience in entire company of at least 6 months. This is necessary because

questions from the survey require internal knowledge about the company's processes and culture. In addition, respondents should have job position not lower than lower-level management or leading specialist. This is important because questions require knowledge about overall organization, not only one function, as well as knowledge about business strategy, ongoing projects and future plans. Ordinary workers do not have such knowledge. One more requirement is higher education that is necessary because questionnaire uses some professional terminology and concepts, which would be better understood by people with university education.

Target sample size is 260 responses. That would by enough for Structural Equation Modeling. Sample size was calculated (and rounded up) with the help of sample size determination formula, which takes into account confidence level, population size and margin of error. In entire research, 17 thsd. manufacturing companies[43], which exist on the Russian market, were used as a population. Confidence level 0,9 and margin of error 5% was chosen. As a result, recommended sample size was identified.

In order to collect responses, mixed would be used. 20% of responses is planned to collect with the efforts of author of entire research, using snowball method: dissemination among acquaintances and acquaintances of acquaintances. The rest 80% is planned to collect using payed target at Anketolog website, where respondent requirements could be set for further dissemination of questionnaire among Anketolog respondent base.

2.4. Conclusion on chapter 2

In the second chapter, 7 factors were selected with the help of literature review and semi-structured interview with expert in Digital Transformation of manufacturing companies for further investigation. Consequently, seven research hypotheses for formulated. Further, Structural Equation Modeling was chosen as a research method for hypotheses test. As a result, research model was formulated, including its visual representation. In order to test the research model, survey was chosen. Questionnaire with 9 sections were developed using either existing Likert scales, either newly developed original scales based on theories:

Section 1. Information about the company and respondent

Section 2. Measuring the level of DT in the respondent's company.

Section 3. Measurement of innovative push in the industry to which company belongs.

Section 4. Assessment of the respondent company's attitude to DT and changes

[43] Industrial map of Russia. Russian production– Access: https://productcenter.ru/map (date: 21.02.2021)

Section 5. Measuring the level of competition in the industry to which company belongs.

Section 6. Measuring the degree of customer orientation in the company

Section 7. Assessment of corporate information systems and technologies

Section 8. Assessment of the state of the industry to which company belongs

Section 9. Measuring business and information system alignment

For questionnaire dissemination mixed approach was chosen: payed target at Anketolog, and the snowball method.

Further chapter would be devoted to the analysis of obtained primary data and discussion of overall research results.

CHAPTER 3. DATA ANALYSIS AND PRACTICAL RECCOMENDATIONS

This paragraph is devoted to the statistical analysis of primary data collected from representatives of manufacturing companies. Further, hypotheses would be checked as well as the research model significance. Based on the results, practical recommendations for manufacturing companies on successful digital transformation process would be developed.

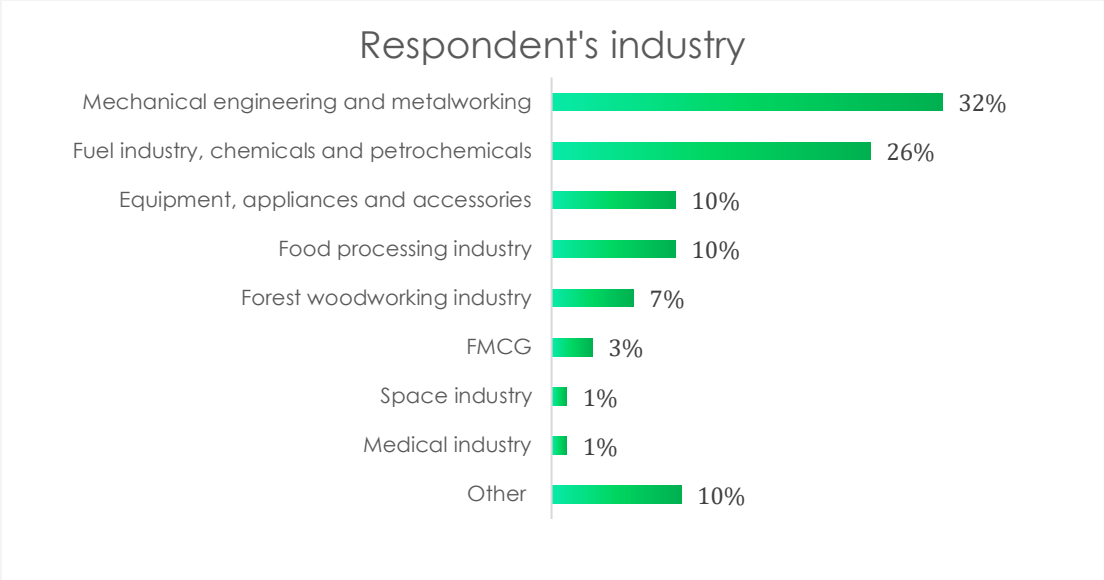
3.1. Data analysis

3.1.1. Sample

In order to collect primary data, questionnaire was created and disseminated using 2 methods: snowball method and payed target at Anketolog platform.

Snowball method implies distribution of survey among author's acquaintances and environment. Social media groups of graduates, master's students and MBA students of GSOM of Saint-Petersburg State University were used for distribution of survey. However, this approach result only into 49 responses and could be characterized with response rate approximately 5%. Therefore, in order to achieve required number of responses Anketolog platform was used. On this platform, user is able to choose requirements for target audience (in entire research: higher education, at least management or leading position, working in production company), enter required number of responses and price for each response. Then, Anketolog sends the survey for its database of respondents, and respondents answer questions for a money. As a result, distribution at Anketolog resulted into 211 responses, with respose rate 89%. To sum up, total sample size is 260. The structure of sample from the perspective of industry branches is represented on the following graph:

source: author's research



Pic 7. *Sample structure*

It could be noted that employees from mechanical engineering and fuel companies are prevailing among respondents. The structure of sample (in terms of industry branch) is similar to the structure of Russian manufacturing industry discussed in paragraph 1.3.: general, transport and equipment engineering (31%, oil and gas sector 23% share, ferrous and non-ferrous metallurgy (17%), and food production (16%) and others.

In terms of company size, the structure of the sample is following: 21% - small companies, 32% medium companies and 47% big companies.

In addition, sample consist of 69% respondents from Russian companies and of 31% respondents from Russian branches of international companies.

All in all, sample is representative because it has structure similar to research object and enough size. The only limitation of the sample could be the deficit of SMEs (53% in entire sample.)

3.1.2. Exploratory Factor Analysis

Next step after conduction of data collection and checking sample for representativeness was exploratory factor analysis. In order to check the reliability of structure of each latent variable, Exploratory Factor Analysis (EFA) was conducted. Main objectives of the EFA were:

1. Validation of questionnaire
2. Testing of latent variables structure (significance of items)
3. Adjustment of model if needed

In order to do EFA questions in a survey was coded and renamed in accordance with latent variables that they represent:

source: compiled by the author

Table 4. *Structure of measurement model*

Latent Variable	Items (questions in survey)	Related to item question
Digital Transformation	DT_1 DT_2 DT_3 DT_4 DT_5 DT_6 DT_7 DT_8 DT_9 DT_10 DT_11	1. Our company has a clear vision of how we will succeed in the digital future, and we are taking the necessary steps to achieve this vision 2. We have the right people, skills, and culture to realize our digital vision 3. We use digital technologies to improve and differentiate our products, services, and customization 4. We have implemented digital technologies in most aspects of our business 5. Business process automation capabilities are regularly identified, evaluated, and implemented 6. We use new technologies such as artificial intelligence, big data, and robotic process automation 7. Our company evaluates and accepts new methods of organizing the workflow (for example, Agile, Lean) 8. The development and implementation of digital initiatives involves not only representatives of IT, but also representatives of other functions 9. We actively use data and analytics to make decisions 10. We regularly identify major gaps in our company's digital capabilities and develop plans to address them 11. 16. Our company successfully transforms digital initiatives from experiments into large-scale projects (including aggressive funding of key initiatives)
Innovative Push	I.Push_1 I.Push_2 I.Push_3 I.Push_4 I.Push_5	1. There are many digital technologies available to our company that can be applied in our industry in the production / sales and distribution process 2. There are many digital technologies available to our company that can be applied in our industry in marketing communications 3. There are many digital technologies available to our company that could be applied in our working (office) life 4. Our main competitors are actively using digital technologies 5. Our company strives to be a leader and stay ahead of the competition in the use of digital technologies
Attitude towards change and DT	Attitude_1 Attitude_2 Attitude_3 Attitude_4 Attitude_5 Attitude_6	1. In our company, the idea of Digital Transformation is supported by the management 2. In our company, the idea of Digital transformation is supported by employees 3. In our company, people DO NOT develop mechanisms and workarounds to avoid change 4. Changes in our company do not stop only at the level of discussions: they actually happen 5. Inevitable changes in our company do not cause fear and dissatisfaction in people 6. We believe that changes in our company are useful because they can "breathe life" into this organization

	Attitude_7	7. Changes in our company are important because they benefit employees
Competition	Competition_1 Competition_2 Competition_3 Competition_4 Competition_5	1. Our company belongs to a highly competitive market 2. There are many active companies in our industry 3. The market is represented by a lot of large and strong players 4. The products created by companies in our industry are not very diverse 5. In our industry, consumers do not have high costs when switching from one brand to another
Costumer orientation	C.Orientation_1 C.Orientation_2 C.Orientation_3 C.Orientation_4 C.Orientation_5 C.Orientation_6	1. We strive to create value for our customers 2. We understand the needs of our customers 3. Our company always strives to meet the needs and expectations of the consumer 4. We have differentiated offers and products for different segments of consumers 5. We regularly measure customer satisfaction 6. We closely monitor the after-sales customer service
Corporate technology	Technology_1 Technology_2 Technology_3 Technology_4	1. The information systems, applications and software used in our company form a single corporate network (i.e. they are all connected to each other) 2. The information systems, applications and software used in our company work well 3. Information systems, applications and software used in our company are not unique (i.e. common in the market of SAP, 1C, Oracle, etc) 4. In our company, information systems are specially developed by the company's specialists (or third-party organizations) in accordance with the company's needs
Market condition	Industry_1 Industry_2 Industry_3 Industry_4 Industry_5	1. Our industry is characterized with unstable profitability and high risks 2. The level of uncertainty in our industry is high 3. Our industry is unstable and volatile 4. Our industry is at the stage active growth or decline 5. Our industry is not supported by the state
Alignment of business and IS	Alignment_1 Alignment_2 Alignment_3 Alignment_4 Alignment_5 Alignment_6 Alignment_7 Alignment_8 Alignment_9	1. In our company, representatives of the IT department could easily come to the management with innovative ideas 2. In our company, information systems and IT create great value for business 3. In our company, the planning of IT resources (financial, human, material, assets, intangible, etc.) is carried out with the joint participation of management and IT representatives 4. In our company, the management understands the basics of IT 5. In our company, the IT department understands the basics of business 6. In our company, employees trust the IT department 7. In our company, IT employees actively communicate with other functions 8. Our company has an IT strategy 9. Information systems and IT — one of the components of our business strategy

The goal of exploratory factor analysis in entire research was to explore whether the stated items are reliable and significant for measurement of stated latent variable. This is important step because the majority of scales (for questionnaire) for latent variables is original, proposed by author and therefore requiring testing. EFA would help to define which items is better to delete from measurement model in order to make it more significant.

- EFA for latent variable "Digital Transformation"

The following table provides a summary on EFA results for stated latent variable:

source: author's research

Table 5. *EFA for Digital Transformation variable*

Item	**Cronbach Alpha if item deleted**	**Factor loading**	**Comment**
DT_1 DT_3 DT_4 DT_5 DT_6 DT_7 DT_8 DT_9 DT_10 DT_11	**< 0,939**	**>0,75**	*Structure of latent construct is reliable and significant*
Latent construct Digital Transformation	Kaiser-Meyer Measure **0, 935** Bartlett's Test significance **0,000** Cronbach Alpha **0,939**		

From the obtained coefficients it could be concluded that factor analysis is applicable in this case because Kaiser-Meyer Measure is equal to 0,935. It shows unconditional adequacy of factor analysis. In addition, Bartlett's Test shows significance because p-value<0,01. Therefore, it could be concluded that data is suitable for conduction of factor analysis. Cronbach's alpha coefficient for Digital Transformation latent construct is 0,939 (min. allowable is 0,7), that indicates internal consistency of measurement items for latent variable. Cronbach's alpha could not be improved if any of items be deleted. Moreover, the factor loadings for each of item is higher than 0, 75, that shows high correlation between item (observed variable) and related latent construct. All in all, structure of latent construct is reliable and significant.

- EFA for latent variable "innovative push"

source: author's research

Table 6. *EFA for Innovative Push variable*

Item	**Cronbach Alpha if item deleted**	**Factor loading**	**Comment**
I.Push_1	**< 0,801**	**>0,7**	*Structure of latent construct is reliable and significant However, Item Push_5 could be further considered for deletion*
I.Push_2	**< 0,801**	**>0,7**	
I.Push_3	**< 0,801**	**>0,7**	
I.Push_4	**< 0,801**	**>0,7**	
I.Push_5	**0,826**	**0,518**	
Latent construct Innovative Push	Kaiser-Meyer Measure **0, 777** Bartlett's Test significance **0,000** Cronbach Alpha **0,801**		

Kaiser-Meyer Measure is equal to 0,777 and Bartlett's Test shows significance because p-value<0,01. Therefore, it could be concluded that data is suitable for conduction of factor analysis. Cronbach's alpha coefficient for Innovative Push latent construct is 0,801, that indicates internal consistency of measurement items for latent variable. However, if item I.Push_5 ("Our company strives to be a leader and stay ahead of the competition in the use of digital technologies") would be deleted, Cronbach's alpha increases up to 0,826. In addition, factor loading, which shows correlation between item (observed variable) and related latent construct, for this item is 0,518. That is satisfactory value. However, taking into account the overall good coefficients obtained in EFA for innovative push, it could be concluded that structure of latent construct is reliable and significant. However, Item Push_5 could be further considered for deletion, depending on the results of CFA and further analysis.

- EFA for latent variable "Attitude to change and DT"

source: author's research

Table 7. *EFA for Attitude to change and DT*

Item	**Cronbach Alpha if item deleted**	**Factor loading**	**Comment**
Attitude_1	**< 0,806**	**>0,7**	*Item attitude_3 should be definitely deleted*
Attitude_2	**< 0,806**	**>0,7**	
Attitude_3	**0,848**	**0** (loading on another component 0,93)	
Attitude_4	**< 0,806**	**>0,7**	
Attitude_5	**< 0,806**	**>0,7**	
Attitude_6	**< 0,806**	**>0,7**	
Attitude_7	**< 0,806**	**>0,7**	
Latent construct Innovative Push	Kaiser-Meyer Measure **0, 847** Bartlett's Test significance **0,000** Cronbach Alpha **0,806**		

Kaiser-Meyer Measure is equal to 0,847 and Bartlett's Test shows significance because p-value<0,01. Therefore, it could be concluded that data is suitable for conduction of factor analysis. Cronbach's alpha coefficient for latent construct Attitude to change and DT is 0,806, that indicates internal consistency of measurement items for latent variable. However, factor loadings analysis revealed that not all items have good fit with latent construct. Item Attitude_3 ("In our company, people do not develop mechanisms and workarounds to avoid change") appeared to has high factor loading with second component, while other items are loaded on the first one. Moreover, if item Attitude_3 would be deleted, Cronbach Alpha for latent construct would be visibly increased up to 0,848. Therefore, item attitude_3 should be definitely deleted.

- EFA for latent variable "competition"

source: author's research

Table 8. *EFA for competition variable*

Item	**Cronbach Alpha if item deleted**	**Factor loading**	**Comment**
Competition_1	**< 0,628**	**>0,8**	*Items Competition_4, Competition_5 should be either deleted or latent variable "competition" could be divided into 2 latent variables*
Competition_2	**< 0,628**	**>0,8**	
Competition_3	**< 0,628**	**>0,8**	
Competition_4	**0,707**	**0** (loading on another component 0,8)	
Competition_5	**< 0,628**	**0** (loading on another component 0,7)	
Latent construct Innovative Push	Kaiser-Meyer Measure **0, 701** Bartlett's Test significance **0,000** Cronbach Alpha **0,628**		

Kaiser-Meyer Measure is equal to 0,701 and Bartlett's Test shows significance because p-value<0,01. Therefore, it could be concluded that data is suitable for conduction of factor analysis. However, Cronbach's alpha coefficient for latent construct competition is 0,628, that indicates low internal consistency of measurement items for latent variable. The main reason for this is that items Competition_4 and Competition_5 are loaded not on the same component with other items. Moreover, Cronbach Alpha if item deleted for Competition_4 is dramatically higher than current Cronbach Alpha for latent construct. Therefore, Items Competition_4, Competition_5 should be either deleted or latent variable "competition" could be divided into 2 latent variables. The final decision would be made based on the results of CFA and further analysis.

- EFA for a latent variable "customer orientation"

source: author's research

Table 9. *EFA for customer orientation variable*

Item	**Cronbach Alpha if item deleted**	**Factor loading**	**Comment**
C.Orientation_1	**< 0,820**	**>0,7**	

C.Orientation_2	< 0,820	>0,7	*Structure of latent construct is reliable and valid, however Item C.Orientation_4 should be under precise attention*
C.Orientation_3	< 0,820	>0,7	
C.Orientation_4	< 0,820	0,63	
C.Orientation_5	< 0,820	>0,7	
C.Orientation_6	< 0,820	>0,7	
Latent construct Innovative Push	Kaiser-Meyer Measure 0, 793 Bartlett's Test significance 0,000 Cronbach Alpha 0,820		

Kaiser-Meyer Measure is equal to 0,793 and Bartlett's Test shows significance because p-value<0,01. Therefore, it could be concluded that data is suitable for conduction of factor analysis. Cronbach's alpha coefficient for costumer orientation latent construct is 0,820, that indicates internal consistency of measurement items for latent variable. However, factor loading, which shows correlation between item (observed variable) and related latent construct, for item C.Orientation_4 ("We have differentiated offers and products for different segments of consumers") is 0,63. That is satisfactory value. However, taking into account the overall good coefficients obtained in EFA for customer orientation, it could be concluded that structure of latent construct is reliable and significant. However, Item C.Orientation_4 could be further considered for deletion, depending on the results of CFA and further analysis.

- EFA for a latent variable "corporate technology"

source: author's research

Table 10. *EFA for corporate technology variable*

Item	**Cronbach Alpha if item deleted**	**Factor loading**	**Comment**
Technology_1	< 0,610	>0,7	*Item Technology_3 should be definitely deleted*
Technology_2	< 0,610	>0,7	
Technology_3	0,702	0 (loading on another component 0,9)	
Technology_4	< 0,610	>0,7	
Latent construct Innovative Push	Kaiser-Meyer Measure 0, 699 Bartlett's Test significance 0,000 Cronbach Alpha 0, 624		

Kaiser-Meyer Measure is equal to 0,699 (equal to min. allowable value) and Bartlett's Test shows significance because p-value<0,01. Therefore, it could be concluded that data is suitable for conduction of factor analysis. However, Cronbach's alpha coefficient for latent construct competition is 0,624, that indicates not enough consistency of measurement items for latent variable. The main problem is in the item Technology_3 (Information systems, applications and software used in our company are not unique, i.e. common in the market of SAP, 1C, Oracle, etc.). It is loaded not on the same component as other items do. Therefore, in case of this item deletion

Cronbach Alpha would increase up to allowable threshold 0, 702. Therefore, item Technology_3 should be definitely deleted.

- EFA for latent construct "industry condition"

source: author's research

Table 11. *EFA for industry condition variable*

Item	**Cronbach Alpha if item deleted**	**Factor loading**	**Comment**
Industry_1	**< 0,770**	**>0,7**	*Structure of latent construct is reliable and valid, however items Industry_4, Industry_5 could be considered for deletion*
Industry_2	**< 0,770**	**>0,7**	
Industry_3	**< 0,770**	**>0,7**	
Industry_4	**0,780**	**0,5**	
Industry_5	**0,829**	**0,5**	
Latent construct Innovative Push	Kaiser-Meyer Measure **0, 769** Bartlett's Test significance **0,000** Cronbach Alpha **0,770**		

Kaiser-Meyer Measure is equal to 0,769 and Bartlett's Test shows significance because p-value<0,01. Therefore, it could be concluded that data is suitable for conduction of factor analysis. Cronbach's alpha coefficient for costumer orientation latent construct is 0,770, that indicates internal consistency of measurement items for latent variable. However, if items Industry_4 ("our industry is at the stage of active growth or decline") and Industry_5 ("Our industry is not supported by the state") Cronbach Alpha coefficient would be visibly increased. Moreover, factor loadings, which shows correlation between item (observed variable) and related latent construct, for these items is 0,5. That is quite satisfactory. However, taking into account the overall good coefficients obtained in EFA for industry condition, it could be concluded that structure of latent construct is reliable and significant. However, Items Industry_4 and Industry_5 could be further considered for deletion, depending on the results of CFA and further analysis.

- EFA for latent construct "Alignment of business and IT"

source: author's research

Table 12. *EFA for alignment of business and IT variable*

Item	**Cronbach Alpha if item deleted**	**Factor loading**	**Comment**
Alignment_1	**All < 0,927**	**All > 0,7**	*Structure of latent construct is reliable and valid*
Alignment_2			
Alignment_3			
Alignment_4			
Alignment_5			
Alignment_6			
Alignment_7			
Alignment_8			

Alignment_9			
Latent construct Innovative Push	Kaiser-Meyer Measure **0, 925** Bartlett's Test significance **0,000** Cronbach Alpha **0,927**		

Kaiser-Meyer Measure is equal to 0,925 and Bartlett's Test shows significance because p-value<0,01. Therefore, it could be concluded that data is suitable for conduction of factor analysis. Cronbach's alpha coefficient for Alignment of business and IT latent construct is 0,927, that indicates internal consistency of measurement items for latent variable. Cronbach Alpha would not be improved if any of items be deleted. Moreover, the factor loadings for each of item is higher than 0, 75, that shows high correlation between item (observed variable) and related latent construct. All in all, structure of latent construct is reliable and significant.

In conclusion, exploratory factor analysis revealed some areas for improvement of the model. Therefore, items Technology_3, Attitude_3, Competition_4 and Competition_5 were deleted from the model. And 4 other items were put under higher attention in further analysis. All in all, Model was corrected and adjusted for further testing.

3.1.3. Research model and hypotheses testing (Confirmatory Factor Analysis)

In entire research the objectives of confirmatory factor analysis were:

- To test the hypotheses
- To conclude on the significance of research model (model goodness)

Amos SPSS software was used in order to perform structural equational modeling and test the model, which consist of latent variables only.

In the paragraph 2.2.2 seven research hypotheses were proposed:

H1: High competition in an industry positively impacts DT of entire company

H2: High innovative pressure and availability of technologies positively impacts DT of entire company.

H3: Alignment of business and Information Systems in an enterprise, positively impacts DT of entire company.

H4: Positive attitude to change and digital transformation positively impacts DT of entire company

H5: Generalized and interconnected technology positively impact DT of entire company.

H6: Instabilities in an industry positively impacts DT of entire company.

H7: High responsiveness of an enterprise to customer needs and expectations positively impact DT of entire company.

To test these hypotheses structure model (initial model, after adjustments to EFA results) was created (see Appendix 1).

Firstly, latent constructs were checked for convergent validity. Critical Ratios coefficients, which should be higher than 1,96, appeared to show good performance for each item of each latent variable. Coefficient higher than 1,96 indicates unidimensionality prove the convergent validity:

source: author's research

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
DT_1	<---	DT	1,000				
DT_2	<---	DT	1,052	,073	14,313	***	
DT_3	<---	DT	,834	,073	11,477	***	
DT_4	<---	DT	1,003	,083	12,048	***	
DT_5	<---	DT	1,198	,081	14,783	***	
DT_6	<---	DT	1,288	,098	13,102	***	
DT_7	<---	DT	1,254	,096	13,120	***	
DT_8	<---	DT	1,156	,088	13,155	***	
DT_9	<---	DT	,956	,078	12,273	***	
DT_10	<---	DT	1,211	,083	14,595	***	
DT_11	<---	DT	1,364	,092	14,781	***	
I.Push_1	<---	I.Push	1,000				
I.Push_2	<---	I.Push	1,006	,071	14,227	***	
I.Push_3	<---	I.Push	,764	,068	11,200	***	
I.Push_4	<---	I.Push	,774	,080	9,654	***	
I.Push_5	<---	I.Push	,668	,099	6,772	***	
Attitude_1	<---	Attitude	1,000				
Attitude_2	<---	Attitude	,932	,085	10,933	***	
Attitude_4	<---	Attitude	1,004	,084	12,024	***	
Attitude_5	<---	Attitude	,936	,095	9,864	***	
Attitude_6	<---	Attitude	1,004	,087	11,529	***	
Attitude_7	<---	Attitude	,742	,081	9,161	***	
Competition_1	<---	Competition	1,000				
Competition_2	<---	Competition	,995	,074	13,430	***	
Competition_3	<---	Competition	,927	,078	11,885	***	
C.Orientation_1	<---	C.Orientation	1,000				
C.Orientation_2	<---	C.Orientation	,787	,073	10,740	***	
C.Orientation_3	<---	C.Orientation	,661	,072	9,179	***	
C.Orientation_4	<---	C.Orientation	,784	,105	7,438	***	
C.Orientation_5	<---	C.Orientation	1,206	,105	11,526	***	
C.Orientation_6	<---	C.Orientation	1,045	,103	10,156	***	
Technology_1	<---	Technology	1,000				
Technology_2	<---	Technology	,743	,104	7,169	***	
Technology_4	<---	Technology	1,214	,115	10,589	***	
Industry_1	<---	Industry	1,000				
Industry_2	<---	Industry	1,105	,050	22,217	***	
Industry_3	<---	Industry	1,031	,052	19,955	***	
Industry_4	<---	Industry	,190	,058	3,294	***	
Industry_5	<---	Industry	,398	,079	5,008	***	
Alignment_1	<---	Allignment	1,000				
Alignment_2	<---	Allignment	,995	,079	12,638	***	
Alignment_3	<---	Allignment	1,080	,082	13,095	***	
Alignment_4	<---	Allignment	,941	,085	11,101	***	
Alignment_5	<---	Allignment	1,084	,083	13,139	***	

Pic 8. *Critical ratio coefficients for each item of each latent construct*

In addition, composite factor reliability and AVE coefficients were found for each latent construct:

source: author's research

Table 13. *Composite factor reliability and AVE for each item of each latent construct*

Latent variable	**Composite factor reliability (> 0.7)**	**AVE (>0,5)**	
Digital Transformation	0, 94	0,61	
Innovative Push	0,82	0,54	
Attitude towards change and DT	0,85	0,49	
Competition	0,84	0,65	
Costumer orientation	0,82	0,48	
Corporate technology	0,78	0,51	
Market condition	0,83	0,55	
Alignment of business and IS	0,93	0,62	

In terms of Composite factor reliability all latent constructs are good (more than 0,7), that means that items have shared high covariances and measure same underlying concepts. However, constructs "Attitude towards change and DT" and "Costumer orientation" could be characterized with quite satisfactory AVE coefficients. This means that their convergent validity is not enough and therefore, the structure of these constructs should be further changed and improved.

Furthermore, obtained model was characterized with bad model fit coefficients and therefore several adjustments (deletion of worsening items and inclusion of additional relationship arrows for correlated errors among 1 latent variable) were conducted.

Following table shows the summary of goodness of fit coefficients for initial model, intermediate models and final one:

source: author's research

Table 14. *Summary on goodness of fit coefficients obtained in CFA*

Model	**X2/df**	**p.value**	**TLI**	**GFI**	**CFI**	**RMSEA**
Model 1 (initial,after EFA adjustments)	3,21	0,000	0,780	0,709	0,804	0,093
Model 2 (deleted c.orientation_4)	3,06	0,000	0,811	0,741	0,835	0,092
Model 3 (deleted industry_4)	3,01	0,000	0,835	0,765	0,857	0,089
Model 4 (deleted industry_5)	2,92	0,000	0,840	0,764	0,863	0,89
Model 5 (deleted attitude_1)	2,92	0,000	0,853	0,794	0,878	0,087
Model 6 (deleted allignment_1)	2,93	0,000	0,869	0,814	0,895	0,084
Model 7 (deleted allignment_6)	2,91	0,000	0,887	0,841	0,917	0,084
Model 8 (deleted attitude_7)	2,92	0,000	0,905	0,850	0,921	0,073
Model 9 (deleted DT_5)	2,91	0,000	0,922	0,872	0,940	0,069
FINAL Model 10 (deleted allignment_9)	2,90	0,000	0,952	0,903	0,969	0,068

- Model 1

Goodness of fit coefficients for Model 1(initial one, after deletion of items Technology_3, Attitude_3, Competition_4 and Competition_5 due to EFA results) appeared to be very bad. Chi square / df ratio (X2/df) should less than 3. TLI, which shows the discrepancy between the χ^2 of the hypothetical model and the χ^2 of the null model, should be higher than 0,9. GFI, which shows

the proportion of variance accounted for by the estimated population covariance and the overall explanatory power of the model, should be higher than 0,9. CFI, which compares the fit of a target model to the fit of a null model, should be higher than 0,9. RMSEA, which shows the extent to how far a hypothetical model is from an ideal model, shouldn't be higher than 0,08. However, it could be noted that all these requirements are violated and model are bad. Therefore, it was gradually changed and adjusted till the moment than good model fit appeared. These modifications result into the gradual deletion of 9 items form different latent constructs.

- Model 2

First of all, items appeared to have doubtful coefficients in EFA, but was left in a model for further check, were deleted. For creation of Model 2 item c.orientation_4 ("We have differentiated offers and products for different segments of consumers") was deleted. In EFA analysis it was characterized with 0,63 factor loading (while values starting from 0,7 considered to be good). Moreover, the error variance of this item has high modification indexes (more than 10) with other errors in a model. This means that covariance error of c.orientation_4 correlates with four other errors of items from other latent constructs. After deletion of c.orientation_4 model fir improved but still was bad. Therefore, additional adjustments were made.

- Model 3

For creation of model 3 item industry_4 ("Our industry is at the stage active growth or decline") was deleted. According to EFA results, its factor loading is 0,5 what is not enough and in case of item deletion Cronbach Alpha of latent which shows internal consistency and reliability would be increased. Moreover, its error has modification indexes higher than 10, i.e. correlates with more than 2 other errors in the model. After deletion of industry_4 model fir improved but still was bad. Therefore, additional adjustments were made.

- Model 4

For creation of model 4 item industry_5 ("Our industry is not supported by the state") was deleted. According to EFA results, its factor loading is 0,5 what is not enough and in case of item deletion Cronbach Alpha of latent which shows internal consistency and reliability would be increased. Moreover, its error has modification indexes higher than 10, i.e. correlates with more than 5 other errors in the model. After deletion of industry_5 model fit improved. Chi square / df ratio reached the good estimation. However, other coefficients still were bad and additional adjustments were required.

- Model 5

In order to create model 5 item attitude_1 (In our company, the idea of Digital Transformation is supported by the management) was deleted. Even though EFA did not reveal any problems with this item, it appeared that modification indexes for error of this item is more than 10 with 10 other errors from the model. This means that error is highly correlated and therefore worsening the model. After deletion of attitude_1 model fit improved, but still not enough.

- Model 6

On the next step of model adjustments, item allignment_1 ("In our company, representatives of the IT department could easily come to the management with innovative ideas") was deleted. EFA did not reveal any problems with this item, however it appeared that modification indexes for error of this item is more than 10 with 4 other errors of other latent constructs. Such correlation badly affects the model. After deletion of allignment_1 model fir improved but still was bad. Therefore, additional adjustments were made.

- Model 7

For creation of model 7 item allignment_6 ("In our company, employees trust the IT department") was deleted. According to EFA results, there is no problems with this factor. However, its error has modification indexes higher than 10, i.e. correlates with 5 other errors in the model. Moreover, its errors show high correlation with other latent constructs (Digital transformation, attitude to change and innovative push). After deletion of allignment_6 model fit improved. CFI coefficients achieved allowable threshold, however RMSEA, TLI and GFI remained bad. Additional adjustments were required.

- Model 8

In order to create model 8 item attitude_7 ("Changes in our company are important because they benefit employees") was deleted. Even though EFA did not reveal any problems with this item, it appeared that modification indexes for error of this item is more than 10 with 5 other errors from other latent constructs. This means that error is highly correlated and therefore worsening the model. Moreover, its errors show high correlation with other latent constructs (corporate technology and innovative push). After deletion of attitude_7 model fit noticeably improved. RMSEA and TLI achieve allowable threshold. However, GFI, which shows the proportion of variance accounted for by the estimated population covariance and the overall explanatory power of the model, still was lower than 0,9. Therefore, more adjustments were made.

- Model 9

For creation of model 9 item DT_5 (“Business process automation capabilities are regularly identified, evaluated, and implemented”) was deleted. According to EFA results, there is no problems with this factor. However, its error has modification indexes higher than 10, i.e. correlates with 2 other errors and 1 latent construct (corporate technology). After deletion of DT_5 model fit improved, but GFI remained lower than 0,9

- Model 10

In order to create model 10 item allignment_9 (“9. Information systems and IT — one of the components of our business strategy”) was deleted. Even though EFA did not reveal any problems with this item, it appeared that modification indexes for error of this item is more than 10 with other latent construct (corporate technology). Moreover, error of this item also correlated with 2 other errors in the model. Deletion of allignment_9 resulted in increase of GFI to 0, 903. All in all, good model fit was achieved and model 10 considered to be the final one.

Model 10 was used for checking of research hypothesis. Following table shows the summary coefficients for hypotheses and final decision on them:

source: author’s research

Table 15. *Testing of research hypothesis*

	Std. Coefficient	Sig.	Hypothesis
DT←Alignment of business & IS	0,257	**	accept
DT←Innovative push	0,143	**	accept
DT←Attitude towards change & DT	0,338	***	accept
DT←Competition	0,168	***	accept
DT← Costumer orientation	0,012	n/s	reject
DT←Corporate technology	0,447	***	accept
DT←Industry condition (instability)	-0,124	***	reject

All in all, 5 hypotheses out of 7 were accepted. Research revealed that positive effect on digital transformation have: high competition in an industry, high innovative pressure and availability of technologies, alignment of business and Information Systems in an enterprise, positive attitude to change and digital transformation, generalized and interconnected technology. The most influential factors are corporate technology and positive attitude towards change. Companies with high performance of these factors more easily and successfully go through digital transformation process.

Research hypothesis number 7 was rejected because of high p-value. It appeared to be insignificant. Possible reasons could be: lack of observations or misperception of respondents about the level of costumer responsiveness. Respondents could believe that their company understands costumer needs and respond to them, but in reality, situation could be different. The

impact of costumer orientation should be further investigated in future researches in order to gain full understanding of this relationship.

Research hypothesis number 6 was also rejected. Even though it's p-value show significance, it appeared that instabilities in an industry negatively impacts digital transformation of entire company. Research showed that the negative consequences of industry instabilities outweigh the flexibility and proactivity (which in turn led to digital transformation) which company gain in unstable market.

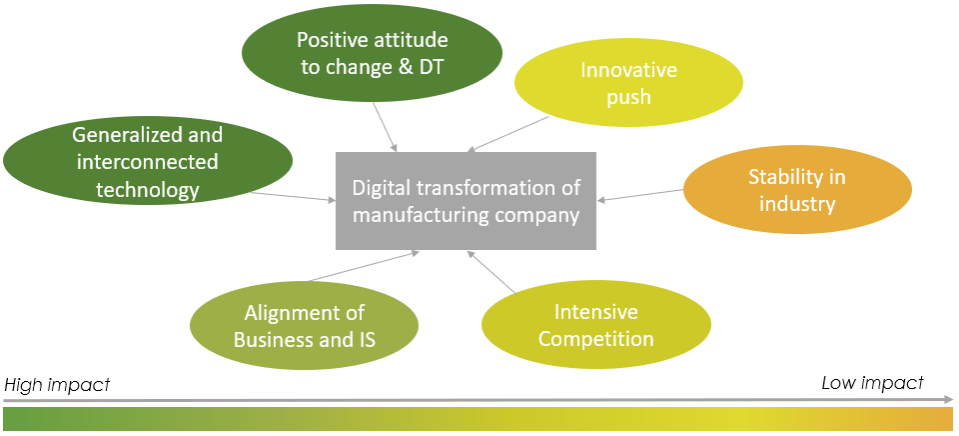
3.2. Discussion

This paragraph would be devoted to the interpretation of statistical results to the business language as well as to development of the list of practical recommendations for successful digital transformation of manufacturing companies. Recommendations would be useful for top and middle managers as well to entrepreneurs interested in transformation of the business and maintenance of competitiveness.

3.2.1. Model interpretation and practical implications

In previous paragraph research hypotheses were checked as well as the model significance. As a result, model with good explanatory power was obtained. This model could be represented as follows:

source: author's research



Pic 9. *Obtained model*

Research revealed six main factors which affect digital transformation of manufacturing companies (represented in descending order by effect strengths):

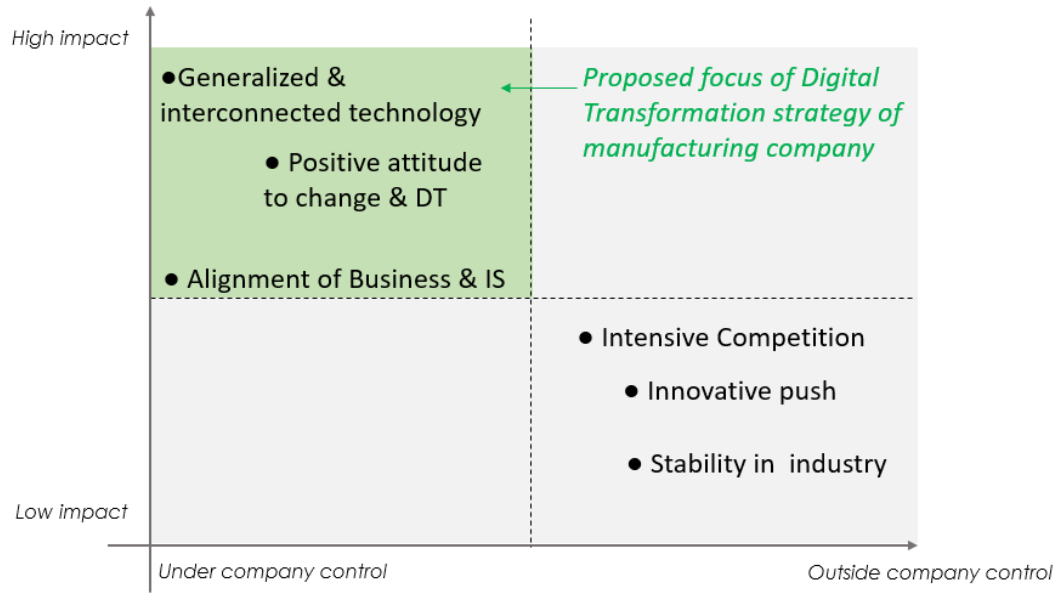
1. Generalized and interconnected technology (corporate technology factor)
2. Positive attitude to change and DT
3. Alignment of business and IT

4. Intensive competition
5. Innovative push
6. Stability in an industry

In order to provide practical recommendations, these findings would be further connected with digital transformation strategy. The digital transformation strategy is an action plan aimed at changing the company's current business model with the help and due to digital technologies adoption.

Factors, identified in entire research could be divided into 2 groups: under control of the company and outside the control of the company. Moreover, research revealed that factors which are under control of the company are more influential on DT success. Therefore, summarized conclusion on the obtained results could be formulated as follows:

source: author's research



Pic 10. *Matrix of factors affecting DT of manufacturing company with proposed strategic focus*

For successful digital transformation companies should include 4 following goals into their DT strategy:

1. To switch to simple and generalized technologies
2. To increase interconnectedness of corporate systems (turn mix of separate systems into one corporate network
3. To increase the positive perception of digital transformation and corporate change
4. To align business strategy and IT strategy of the company

Further, these 4 goals would be divided into several strategical actions.

- *Switching from unique, noncompatible technologies to generalized and simple one*

For successful digital transformation technologies used in a company should be suitable for transformation i.e. compatible and easy to work with. Companies should make the decisions about adaptation of some technology not only on such criteria as costs and benefits to a company, but also take into the account compatibility of entire technology with other technologies, their flexibility and user-friendliness. This criterion should be assigned a significant weight in decision making process. If company has already adopted opposite technology, it's important to initiate preparatory step in digital transformation process which would be devoted to replacement of the technologies or (when it's not possible to replace) refinement and adjustment of it by a team of specialists.

- *Increase of interconnectedness of corporate systems*

Nowadays, many companies use several information systems for different purposes and these systems are absolutely not connected with each other. For example, it's quite typical then company use 1C or SAP for accounting, budgeting and financial control, separate software for logistics and inventory management, other software for marketing activities and costumer tracking and etc. However, such separation slows down the DT process because in such situation each system requires separate approach. Moreover, not connected systems are less flexible and therefore slowing down the changes. In order to overcome this, company should create a single corporate network, which greatly simplifies the interaction between departments.

In most cases, VPN technology (namely Site-to-site VPN) is used to create such a system. It allows not only to conveniently combine the company's branches into a single network, but also to provide a high level of security through the use of encryption.

Single corporate network based on a VPN (Virtual Private Network) provides a large list of features[44]:

- Own Intranet (internal Internet). Allows to conveniently and securely share files between company employees.
- IP telephony and video conferencing. A convenient tool for ensuring communication between the company's staff, regardless of their location.
- Using Active Directory services. It is a distributed database that is used as a single point of authentication and authorization of users.

[44] Organization of corporate networks based on VPN: building, management, security. VPN Side, 2019. Access: https://www.vpnside.com/ru/organizatsiya-korporativnyh-setej-na-o/ (date 19.04.2021)

- Data encryption. VPN technology supports data encryption, which allows you to protect your company's internal data from unauthorized access.

All in all, a single network based generates many bonuses for a company. It provides a high level of security, supporting a large number of functions necessary for the comfortable functioning of the company and increase the flexibility and decision-making speed of organization.

- *Increasing of the positive perception of digital transformation and corporate change*

For smoother and more successful DT of the company it's important to work with corporate culture and promote digital transformation in a positive way. Companies should initiate special cultural transformation campaign which would be based on such tools as: communication sessions with management, feedback collections, inspiring posters and visuals in the working places, informing and motivational mailings and etc. Seven objectives should be achieved[45]:

1. Creating a sense of the need for change among employees.

To do this, management should inform employees about the main preconditions and reason for transformation pinpointed with measurable evidence (poor performance of the organization in comparison with competitors, dissatisfaction of large customers of the organization, information about new laws and regulations governing the activities of the organization, positive effects of digital transformation and etc.). If management consciously focus the attention of employees on the shortcomings in the organization of work and on the negative consequences to which they lead, then they will gradually form a sense of the need for change.

Companies that do not recognize the urgency of change tend to have more complications and greater resistance to change than those that feel the urgency of reform, where the transformation has not been postponed. The sense of urgency serves as a catalyst to overcome resistance, ignite the spark that will immediately start the action, and give the impetus necessary for the successful implementation of the transformation at its very beginning.

2. Create an understanding among employees that management and influential people support DT

The explicit commitment of management to the ongoing changes has a positive effect on creating an appropriate mood among subordinates. Employees should see that people who have decision power, respect and authority in a company consider digital transformation is important and necessary change.

3. Involvement of employees in goal-setting and decision-making

[45] Kotter, J. P., & Schlesinger, L. A. (1989). Choosing strategies for change. In Readings in strategic management (pp. 294-306). Palgrave, London.

It is a well-known method of activating employees and involving them in the management of an organization. This method of influence is based on the premise that if an employee is interested in participating in the activities of the organization and receives satisfaction from his work, then he works more productively and efficiently. The participation of employees in the management can be carried out in different forms. For example, they may be involved in setting goals and identifying problems, making group decisions, or may be granted operational control over product quality. This also means the independence of the performer in the performance of his work in terms of its mode, the means used in the performance of the task, etc. Involving employees in management allows them to liberate their creative activity, create space for individual achievements of capable people, and at the same time ensure the necessary integration of individual efforts into a single collective action.

4. Support of innovators

This implies all-round assistance to creative, unconventional people. It should be borne in mind that there are usually few innovators in the total mass of employees. In this regard, there is the term "active minority" - these are the initiators and guides of new ideas, developments, experiences, etc.

5. Hire necessary people

It’s important to attract right people who are able to implement new ideas and innovations that have already been developed. If an organization lacks active idea generators and change implementers, it may try to attract them from the outside.

6. Active use of the internal communications system

The fact is that the directed flows of information create a right psychological atmosphere and a corresponding mood, help to avoid conflicts and misunderstandings. The communication management system in the organization should provide information support for management decisions, including information support for change management. As a result, the resistance to change on the part of the organization's employees will be reduced. On the contrary, poorly informed employees in the absence of competent communications become passive and resist everything that is offered to them, so each subsequent change is more problematic than the previous one.

7. Use of informal communication channels.

Along with the use of formal channels of information transmission (internal computer network, various types of newsletters, official mailings of orders, etc.), it is necessary to use channels of informal communication of employees with each other. The fact is that information about important and relevant issues related to transformation changes people's attitudes more and faster

when it is transmitted through informal channels. For example, such information can be shared with employees in an informal conversation. Then it will quickly spread between colleagues.

- *Alignment of business strategy and IT strategy*

Alignment of business and information systems is a situation when information technologies (IT) and information systems (IS) serve to fulfill company business goals and achieve it's mission, when company transform its business model in such a way that IT and IS become not a separate function, but an indispensable, essential aspect for business.

Strategic Alignment of business and IT should cover 6 main areas[46]:

1. Communications

Communication imply effective exchange of information and knowledge between business representatives and IT representatives. In order to do so IT and business representatives could gain cross functional knowledge and skills (through training and communication sessions) to be able to "speak the same language". It is important that business and IT representatives could understand each other, Moreover, effective communication should be regular and structured in order to make both sides aware of ongoing activities and procedures, to define how each side could contribute to the implementation of current tasks.

2. Measurement of IT value

It is important to establish metrics (KPIs) not only for business as a whole and separate metrics to IT function, but to develop metrics which show the value of IT on the business. Metrics could be both quantitative (ROI for digital projects, economy effect as a result of technology usage, etc.) and qualitative (employee or costumer satisfaction, etc.). Such metrics should be regularly checked and maintained in order to reach target values. This will allow to control alignment effectiveness and make adjustments when it's needed.

3. IT governance

IT governance involves empowering IT function (and its representatives) to make IT decisions and to plan processes at the strategic, tactical, and operational levels, to set IT priorities and allocate IT resources on an equal basis with business representatives (management). This implies changes in organizational structure, procedures and reporting. Company should align its business strategy with IT priorities, technical planning, risk management and budgeting.

4. Technology scope and architecture

[46] Sledgianowski, D., Luftman, J., & Reilly, R. (2004). Identification of IT-business strategic alignment maturity factors: an exploratory study. AMCIS 2004 Proceedings, 470.

This component covers the technological infrastructure of the company. It should be flexible and transparent in order to maintain organizational changes, and help in development of customized solutions.

5. Partnerships

This area implies creation of partnership between business and IT function. For this purpose, business and IT should perceive the value of each other in a right way. They should give shared goals, risks and remuneration in order to work together with single purpose. Relationship management should be focused on the increase of trust between both sides.

6. Skills

This aspect covers human resource skills of the company. Skills of IT representatives definitely should be developed and improved, but not only in the technological sphere. IT representative should have an opportunity to gain cross-functional education, develop dynamic capabilities and be not only technical specialist but also be able to provide some strategic consultancy. Moreover, skills aspect includes company's maturity in change management and development of related skills among its employees.

To conclude, mentioned main objectives were divided into substeps and organized in a form of recommendations for manufacturing companies.

3.2.2 Gazprom Neft experience

In order to pinpoint practical recommendations, the experience of Gazprom Neft (GPN) company would be used in order to show on real example how digital transformation of manufacturing company is made and how it reflects 4 main recommendations proposed in entire research.

Gazprom Neft was chosen because it one of the leaders in Digital Transformation on the Russian market. DT is part of the comprehensive business transformation of Gazprom Neft company, which is conducted to achieve the strategical goals 2030 of the company. Today, Gazprom Neft is already implementing hundreds of digital projects along the entire value chain, and they bring tangible economic benefits. Among ongoing digital projects there are: automatic core recognition system (based on artificial intelligence), blockchain technology – Smart Fuel, Manufacturing of equipment parts using three-dimensional computer modeling and many others. Moreover, Gazprom Neft is a huge company with matrix structure, numerous departments and subsidiaries. Therefore, in order to realize digital transformation in such a company, proficiency and deep expertise were developed.

This paragraph would include exact examples of Gazprom Neft experience in the areas proposed in entire research as recommendations.

- Switching from noncompatible technologies to generalized & simple one and increase of interconnectedness of corporate systems

One of the main goals of digital transformation in Gazprom Neft is creation of a unified platfrom, interconnected network of systems and technologies which work cohesive for achievement of corporate goals and sustainable competitive advantage. Therefore, company actively increase level of integration and integration among it's systems. Important fact should be mentioned, is that Gazprom Neft is a really huge company with complex structure and multiple processes. Therefore, it managed numerous amounts of systems (≈ 100), well-known softwares QlickView, Oracle Hyperion Planning, CRM, 1C, SAP ERP, Tessa (TESSA electronic Document Management System), Automated control System on gas stations, and developed by GPN systems (for example, Unified Logistics Management Automation System – ESAUL). Gazprom Neft is an example of company which face the need to integrate all of its systems, but that was difficult to do by using current systems and systems only available on the market. Therefore company pays a lot attention to development and modification of own systems in order to make them compatible. Currently, GPN has separate departments which are responsible for integration of corporate systems. For today, approximately 40 integrations are in progress, and according to digital transformation strategy due to 2023 this number should be increased to 80.

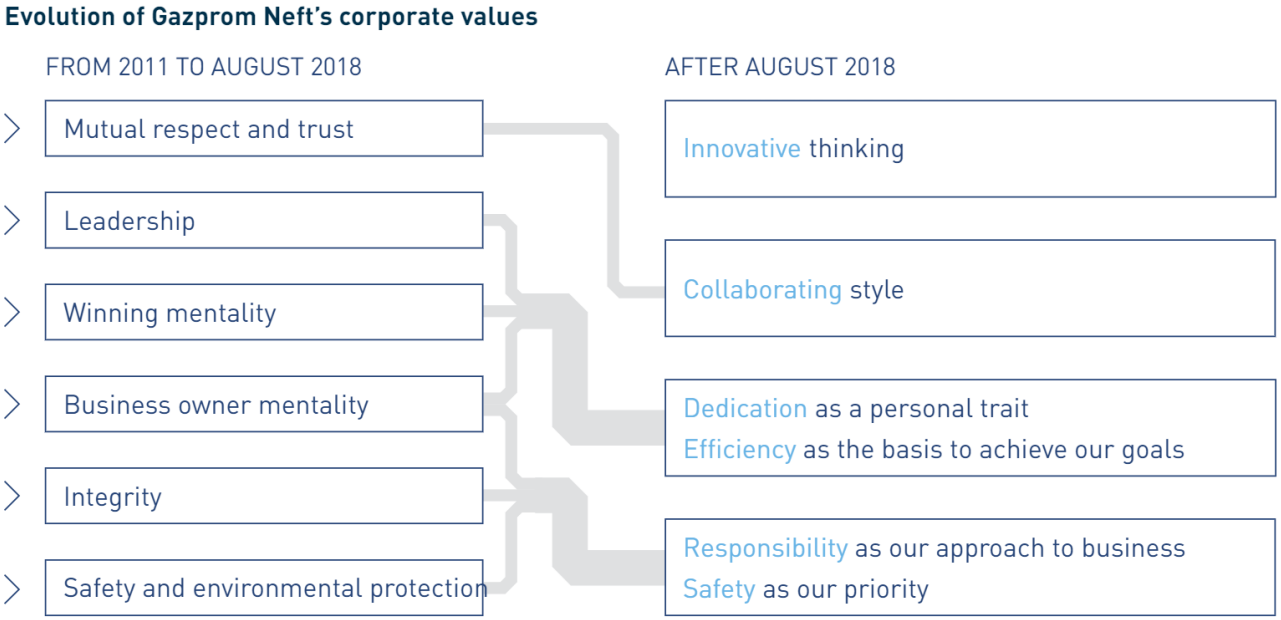
In order to make its systems more compatible from the very beginning, GPN proposed unified standard systems which include some main standards for corporate technologies. This helps to somehow standardize adopted technologies, and therefore make more compatible. For example, Gazprom Neft implements design-system Consta- a library of components and clear rules for their interaction — everything that designers and developers need for creation of interfaces. This system helps the company to make interfaces faster, simpler and more compatible with each other.

All in all, main approaches for success of GPN in the area of interconnectedness and compatibility, which could be used as a benchmark for other companies are: 1) clear movement towards the creation of an integration platform, 2) creation of special departments responsible for integration and connection of current systems, 3) usage of well-known systems produced by world leading brands in a combination of own developed systems (specially for subsequent implementation in a single platform).

➢ Increasing the positive perception of digital transformation and corporate change

The work with the perception of digital transformation in Gasprom Neft starts from the very inside, from it's corporate culture. During last 4 years company switching from management to inclusive leadership as a new ideology of interaction[47]. Company creating an atmosphere where each employee is engaged into improvement and advancement of organization. Following picture shows how Gazprom Neft transform the corporate values in 2018:

source: Gazprom Neft annual sustainability report, 2019



Pic 11. *Evolution of Gazprom Neft corporate values*

It could be seen from the picture that today company actively supports innovativeness and collaboration. This has positive effect of digital transformation because employees are eager to innovate and work together (a sense of unity makes it easier to get through corporate changes).
In order to deliver this values and motivate employees GPN not only use traditional methods (informing during meeteng, show on the web-site and corporate portals), but also adjust design of its ofices. For example, in Saint- Petersburg office, company uses motivational slogans on the office walls. It includes such words as: power, innovation, agile, success, flexibility, learning, improvement, collaboration and so on.

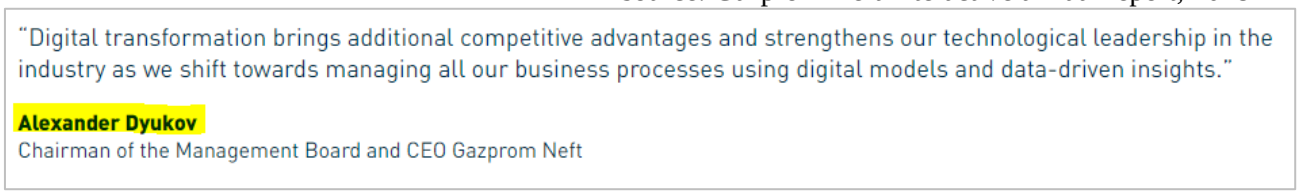
[47] Gazprom Neft, Annual Report, 2018. Access: https://ar2018.gazprom-neft.ru/profile/company (date: 17.05.2021)

source: “Walking around the office” habr.com

Pic 12. *Motivational slogans in the GPN offices (attributes of corporate culture)*

Apart from corporate culture, GPN undertake a full-fledged promotion of the company's digital transformation within the organization. Each annual and quarterly conferences, important meetings and interviews raise the topic of digital transformation and its importance for the company's success. GPN actively broadcasts its vision for becoming the most digital vertically integrated oil company. Employees regularly obtain information that without digital transformation GPN would lose its leading position. In addition, Gazprom Neft shows its employees that top management and corporate leaders support and cares about digital transformation. For example, company’s top management regularly speaks positively about DT:

source: Gazprom Neft interactive annual report, 2018



Pic 13. *Citation of Alexander Dyukov support for DT*

In order to inform employees about this support and need for DT, GPN uses internal communication channels as well as informal ones. GPN has its personal assistant program which not only automated work of technical support, but also provide informing mailings with news and goals of the company. Employees regularly receive emails form personal assistant about digital transformation achievements, events and interviews with management about DT. Moreover, GPN uses corporate telegram channel "G-Drive" and corporate employee portal for rising awareness and increase positive perception of employees about DT.

In addition to informing and promotion of Digital Transformation, GPN actively engages employees into the DT process. Even though DT was initioated by management (from above), DT activities and ideas go from all employees (from below). Company uses approach of collection about employees pains and challenges, which further is used for development of digital initiatives and projevcts. Moreover, company provide its employees with the platform for ideas collection "the idea factory", where employees could exchange their innovative ideas devoted to business improvement. With such approach GPN create an innovative atmosphere where everyone contributes to the transformation of the company.

All in all, Gazprom Neft uses a multi-faceted and versatile approach to engage employees in digital transformation as well as to decrease of change resistance and increase innovativeness from below.

- Alignment of business strategy and IT strategy

As it was mentioned, Difital Transfromation of Gazprom Neft is a part of business strategy of the company. The main goal of DT for today is realization of the additional potential for increased efficiency and security through new digital tools. Company believes that Digital Transformation creates additional competitive advantages for the Company and strengthens its technological leadership in the industry[48].

[48] Gaprom Neft Annual Report. (2018). Digital Transformation. Online access: https://ar2018.gazprom-neft.ru/strategic-report/digital-transformation/materials/#question-1 (access date 21.05.2021)

Digital Transformation during several years are a part of strategical planning of the company. Gazprom Neft has its digital strategy and vision, which are aligned with business strategy of the company.

Source: internal materials of GPN and annual reports

Table 16. *Gazprom Neft alignment of business and digital transformation strategy example*

Business strategy	Digital strategy[49]
The Goal of the company "***Become one of the best industrial companies in the world***, defining the progressive transformation of the industry, making the impossible real and ***inspiring other companies in Russia and abroad***."[50]	**The Goal of DT** Realization of the additional potential for increased efficiency and security through new digital tools for achievement long-term strategic advantage and ***becoming an industry benchmark for efficiency and technology***.
Costumer orientation of the company Gazprom Neft's main task of the business is to create value for the customer and provide Best customer solutions	**Achievement of costumer orientation through product-centred approach of DT.** -To achieve maximum efficiency, this approach borrows working formats from the field of information technology-cross-functionality and multi-team. Working in teams will facilitate the creation of new products for both external customers and for the Company's divisions. -Implementation of AI and IoT solutions: personalized offers to customers, dynamic pricing
Development of own business ecosystem A network of organizations (including suppliers, distributors, customers, competitors, government agencies, etc.) involved in the delivery of a particular product or service, both through competition and cooperation. Such a network creates collective value for a common set of customers.	**Development of Unified Digital Management and Sales Platform** Unified platform developed by Gazprom Neft – a set of business processes and digital products that support the sales business of PJSC Gazprom Neft. It includes end-to-end digital solutions for the whole steps of supply chain from optimal inventory order to services for end customers and partners, as well as automation of support and accounting processes that implement specific requirements of the company.
Constant optimization of the value chain and fast, optimal decision-making	**Data-driven decision making** -creation of a data lake: in order to significantly improve the speed and quality of decisions made company developing a unified data management system that could provide timely access to the huge

[49] Internal corporate materials of Gazprom Neft: Digital Strategy 21-23, Comprehensive development program digital sales platform

[50] Gaprom Neft Annual Report. (2018). Digital Transformation. Online access: https://ar2018.gazprom-neft.ru/strategic-report/digital-transformation/materials/#question-1 (access date 21.05.2021)

	amounts of data generated by the company on a daily basis. - digital expert systems: artificial intelligence, machine learning, digital twins etc.
Cost reduction and EBITDA increase through business transformation	**Main digital projects for achievement of this strategical goal:** - Staff optimization through IT: Development of remote banking services, introduction of a mixed work format (remote + coworking) -Applying AI algorithms: simulation of operational process through digital twins -Autonomous software robots for execution routine work (on a virtual machine) -Monetization of IT projects - own SaaS solution for gas station management -Creation and development of an electronic trading platform for the purchase of petroleum products in the small wholesale channel, integrated with commercial accounting systems, which allows you to set a fair price depending on demand and guarantee the reliability of supplies thanks to a flexible pricing tool and mechanisms for prompt purchase under an offer agreement without prior requests -e-commerce: Creating own online store with delivery via network of gas stations and courier delivery -etc.

Using Strategic Alignment Maturity Model by Luftman (theoretical base used in entire research for alignment factor analysis and questionnaire development) case of Gazprom Neft would be analyzed. From the communication perspective, Gazprom Neft supports cross-functional teams creation, where IT and business representatives could work together and share their knowledge. From the governance perspective, Gazprom Neft has such a structure where authority to affect IT and digital projects is represented through most of the company level (not only top management or only IT personnel). Each directions and each departments has its budget for digital projects and authoritative person involved in decision-making process. In addition, Gazprom has matrix organizational structure that allows fast interdepartmental communication, facilitation of digital projects and cross functional learning. From the partnership perspective, Gazprom Neft implements programs of team spirit development between IT and Business representatives, system of shared goals (IT goals corresponds with business goals) and business responsibility (both IT and business are responsible for achievement of KPIs). From the scope & architecture perspective, GPN has flexible, connected technological infrastructure which company plane to transform in

fully connected platform. From the skills perspective, as it was mentioned, GPN supports cross-functionality and therefore provide regular trainings for its personnel (for development of digital and business s skills) and attract not only IT personnel for digital transformation related positions, but talents from different backgrounds. From measurement perspective, Gazprom Neft developed a set of KPIs for accessing performance of digital strategy. These KPIs evaluate the cumulative effect from digital projects for a whole business (volume growth, share of cost reduction, time reduction etc.) and both IT and business are responsible for achievement of these KPIs.

All in all, GPN shows high level of strategic business and IT alignment. Main success prerequisites which could be used as a benchmark for others are: 1) development and realization of digital transformation strategy together with business strategy; 2) Sharing of responsibility for achievement of business strategical and digital goals between IT and management representatives; 3) Matrix corporate culture; 4) Development of cross functional knowledge.

3.2.3 Limitations and further research

Entire research has several limitations. To start with, it has geographical limitations. Research is focused on Russian companies and international companies operating in Russia i.e. research is limited to the Russian market. On the other markets results of such model testing could be different. Secondly, research could be characterized with industrial limitation as it is focused only on manufacturing companies. This industry has its own specifics and special range of digital technologies which could be applied only in production. Third limitation is connected with obtained sample. There is a lack of small companies in it. On average, small companies are less digitalized than big ones, and therefore further research could be done to investigate specifics of digital transformation of small manufacturing companies.

There are several directions for further research. First of all, it is necessary to precisely investigate the relationship of industry stability and digital transformation process. Entire research revealed some controversy in theory connected with this factor. Initial hypothesis about positive impact of instabilities in an industry was rejected because analysis of primary date shows the opposite effect. It is important to conduct in-depth analysis of positive and negative effect of unstable industry on Digital transformation of manufacturing companies. Probably, qualitative research would better suite for this purpose. Second direction of further research is the analysis of effect of costumer orientation on DT of manufacturing companies. In entire research hypothesis about this relationship wasn’t accepted because of statistical insignificance. However, existed theory provided many evidences on the existence of this relationship. Therefore, it should be further investigated and analyzed. Third proposition for further research is the narrowing of application

of developed research model to a specific industry branch. For example, future research could be devoted to oil & gas companies and their specifics.

3.3 Conclusion on chapter 3

In the third chapter research model was tested and hypotheses were checked. As a result, research revealed six main factors which affect digital transformation of manufacturing companies (represented in descending order by effect strengths):

1. Generalized and interconnected technology (corporate technology factor)
2. Positive attitude to change and DT
3. Alignment of business and IT
4. Intensive competition
5. Innovative push
6. Stability in an industry

While hypothesis about positive impact of industry instabilities (research revealed negative impact) and costumer orientation (due to insignificance) were rejected. Based on the obtain results practical recommendations were proposed in 4 areas. Recommendation include 4 perspectives:

- Switching from unique, noncompatible technologies to generalized and simple one
- Increase of interconnectedness of corporate systems
- Increasing of the positive perception of digital transformation and corporate change
- Alignment of business strategy and IT strategy

Finally, recommendations were pinpointed with the example of Gazprom Neft company -one of the leaders in digital transformation in Russian manufacturing industry. Main activities and approaches of Gazprom Neft were analyzed from 4 perspectives mentioned above.

CONCLUSION

The goal of entire researh was to identify factors which affect the process of digital transformation in manufacturing companies. In order to achieve this goal several activities were undertaken. In Chapter 1 most recent and relevant researches in the area of Digital Transformation of manufacturing companies were studied. As a result, research gap was formulated. It implies the need in further research in the area of factors affecting digital transformation of manufacturing companies due to: 1) prevalence of traditional theories which were developed many years ago not for Digital transformation phenomena; 2) absence of clear understanding of manufacturing industry specifics. In addition, chapter 1 covered specifics of Digital Transformation in Russian manufacturing industry such as active governmental support and financial limitations as a main barrier. Chapter 2 was devoted to the development of research model. Based on the literature review list of factors affecting digital transformation was formulated. Then, based on combination of literature review and semi-structured interview with expert in DT from Gazprom Neft seven factors were chosen for further in-depth analysis:

1.Innovative push
2.Attitude to DT and change
3.Competition
4.Responsiveness to customer needs and expectations
5.Corporate technology
6.Market condition
7.Alignment of Business & IS

Then, seven hypotheses and research model were formulated. It represents a combination of Diffusion of innovation theory (individual characteristics) and Technology, Organization, and Environment theory (technological and environmental factors) and 2 more strategic aspects described on modern theories (alignment of business and IS, costumer orientation). For testing this model Structural Equational Modeling approach was chosen, including exploratory factor analysis and confirmatory factor analysis. For collection of primary data survey method was chosen and questionnaire consisted of 58 questions were developed. Questionnaire was disseminated among representatives of manufacturing companies. As a result, 260 responses were collected.

Chapter 3 is devoted to data analysis and development of practical recommendations. Statistical analysis showed that model require some adjustment. After adjustments, final model was formulated. Goodness of fit coefficients show that model is significant and has good explanatory power. As a result of hypotheses check, 5 hypotheses out of 7 were accepted. Research revealed

that positive effect on digital transformation have: high competition in an industry, high innovative pressure and availability of technologies, alignment of business and Information Systems in an enterprise, positive attitude to change and digital transformation, generalized and interconnected technology. The most influential factors are corporate technology and positive attitude towards change. Companies with high performance of these factors more easily and successfully go through digital transformation process. Relationship between digital transformation and factor costumer orientation appeared to be insignificant and therefore required further investigation. Relationship between digital transformation and factor industry instability appeared to be negative, however initial hypotheses propose positive effect. Therefore, this relationship also requires additional investigation. Based on the obtained results, strategical recommendation were formulated. They include 4 main directions, which should be covered in digital transformation strategy of manufacturing companies: 1) Switching from unique, noncompatible technologies to generalized and simple one; 2) Increase of interconnectedness of corporate systems; 3) Increase the positive perception of digital transformation and corporate change; 4) Alignment of business strategy and IT strategy. In addition, these recommendations were augmented with Gazprom Neft example as a benchmark for other manufacturing companies.

All in all, research goal was achieved and research questions were answered.

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APPENDICES

Appendix 1. Results of selection of factors for research model based on intervview with expert and literature review

Factor	Score
Availability of technology/ Innovative push	10
Attitude towards change	10
Competition	10
Expectations and demand (responsiveness to it)	10
Customer behaviour (responsiveness to it)	10
Expected benefits of DT	10
Management support	10
Employee support	9
Alignment of Business and IS	9
Interconnectedness	8
Specifics of technology (complexity, compatibility)	8
Industry & market specifics(industry pressure, uncertainty, condition)	8
Level of cyber security	7,5
CEO's innovativeness;	7,5
CEO's IS knowledge	7,5
Governmental regulation (pressure/support)	7
Technology support	7
Technology readiness	7
Technology competence.	7
Supportive corporate culture	7
System opennes	7
Dynamic capabilities	7
Availability of data	7
Development of digital business strategy	7
Financial stability of a company	7
Level of company's formalization and centralization	6
Technology infrastructure	6
Leverage external and internal knowledge	6
Complexity (of organization)	5
Managers and employees engagement	5
Cooperation with digital natives (digitally born firms)	4
Company size	3
Slack	3

Innovative push
Attitude to change & DT
Competition
Responsiveness to customer needs & expectations
Alignment of Business and IS
Corporate technology
Market condition

Appendix 2. Initial structural model for AMOS SPSS