FACTORS AFFECTING DIGITAL TRANSFORMATION
OF MANUFACTURING COMPANIES

Abstract.

The goal of these research is to identify factors which affect the process of digital transformation in manufacturing companies. 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: innovative push, attitude to DT and change, competition, responsiveness to customer needs and expectations, corporate technology, market condition, 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). Based on the obtained results, strategical recommendation were formulated.

Keywords. digital transformation, Diffusion of innovation (DOI) theory, Technology, Organization, and Environment (TOE) theory.

1. Introduction

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.

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.

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. 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.

2. 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%).

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.

3. Methodology
Theories about factors affecting 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. 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.

Selection of factors

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.

Hypotheses and research model

Based on literature review and semi-structured interview seven factors were selected 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

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

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

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

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

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

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

SEM analysis was implemented to test research hypotheses.

4. Empirical results and conclusions

As a result 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.

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