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INDUSTRY 4.0 AND PREPARING COMPANIES FOR IMPLEMENTING IT

Dissertation

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Declaration

I declare that I have elaborated the dissertation independently using only the listed literature and sources.

In Hradec Králové, 10.4.2019

Majid Ziaei Nafchi

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Annotation

Industry 4.0 has attracted much attention from researchers because of the benefits it has to offer. However, most of the previous studies have been concerning the technological aspects of Industry 4.0 and the social dimension of Industry 4.0 has been understudied. The focus of this dissertation is about the organizations readiness for implementing industry 4.0 from the point of view of the organizational culture. Results show that the size of an organization does not affect the level innovative culture, which is considered a pre-condition for implementing industry 4.0. On the other hand the type of ownership of the organization affects the innovative culture level. The obtained results, together with the results extracted from the literature review are used to better evaluate organizations readiness and to choose more appropriate managerial methods for implementing Industry 4.0.

Keywords: Industry 4.0, Readiness, Organizational culture

Anotace

Průmysl 4.0 vzbudil velkou pozornost ze strany výzkumných pracovníků kvůli výhodám, které nabízí. Většina předchozích studií se však týkala technologických aspektů Průmyslu 4.0 a sociální dimenze Průmyslu 4.0 byla podceňována. Tato disertační práce se zabývá připraveností organizací k implementaci Průmyslu 4.0 z pohledu organizační kultury. Výsledky ukazují, že velikost organizace neovlivňuje úroveň inovační kultury, která je pokládána za předpoklad pro implementaci Průmyslu 4.0. Na druhé straně, typ vlastnictví organizace ovlivňuje inovační úroveň kultury. Získané výsledky spolu s výsledky získanými z literárního výzkumu slouží k lepšímu zhodnocení připravenosti organizací a výběru vhodných manažerských metod pro implementaci Průmyslu 4.0.

Klíčová slova: Průmysl 4.0, připravenost, organizační kultura

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1 Introduction

Industry 4.0 is which is believed to be the essence of the fourth Industrial revolution, is currently being used in manufacturing by utilizing cyber-physical systems (CPS) in order to grasp high levels of automation (Ziaei Nafchi & Mohelská, 2018a). The Cyber-Physical System (CPS) is the foundation for smart factories and interconnect sensors, machines and IT systems within the value chain across enterprise boundaries (Kopp & Basl, 2017).

Using mostly foreign sources to have a more international view towards the research composed the Literature review of this work. The Literature review revealed that the technological aspect of the Industry 4.0 concept has been well studies and documented. However, the other aspects concerning organizational culture have been understudied, and this could be considered as the "gap in the Literature".

The main objective of this work is to examine the level of organizational culture in organizations to seek appropriate managerial approaches and methods for the development of organizational culture in a manner that could support the environment for innovation in the organization, in order to facilitate entrepreneurship in the Industry 4.0 concept.

To realize the objectives of this work the Wallach's Questionnaire (1983) is chosen as the most appropriate method for the research. In addition The Hofstede model of six dimensions of national cultures could be considered to find out its possible use for defining the organizational culture preconditions for implementing industry 4.0.

2 Analysis of the current state of the subject of the proposed dissertation

2.1 Information Management

In today's economy Information management plays a vital role. It needs substantial investment and provisions critical business processes. With the multiplication of the information systems and information economy, effective information management governs success of nearly every business operation. Procurement of business value from huge amount of information that is collected through businesses is not only a technological challenge any more. Choosing proper decision-making tools and information solutions remains not only with the business, but also with IT managers (Benson & Tribe, 2009).

Information is considered to be uncertainty-reducing knowledge, and it is one of the components in the processes of business operations integration. Nowadays, information has become value and similarly power, if used properly. It is of major importance for organization off different sizes, from small organizations to multinational corporations, to be able to manage information as quickly and accurately as possible (Csapó et al., 2018).

Rethinking and reconsidering of the business processes and information management, which are shown below in figure 1, may obtain several advantages:

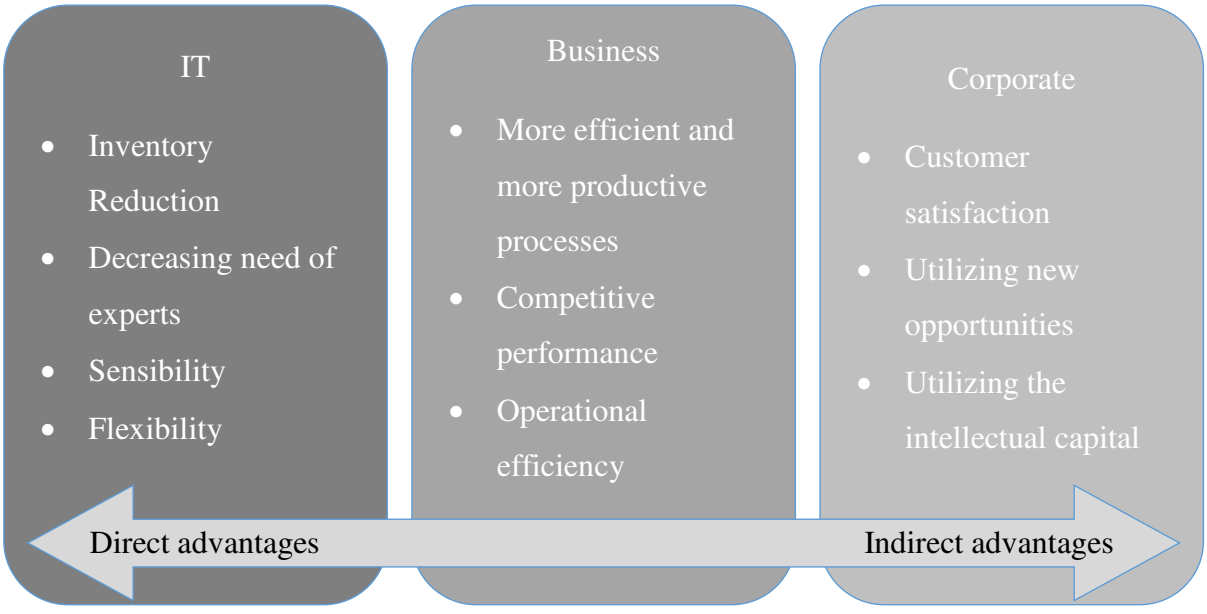

Figure 1: The benefits of proper information management

Source: (Csapo et al., 2018; Author)

Bytheway (2015) believs that the logical connections concerning technology capability, cost, and strategic need (and benefits), could be understood by the help of a model called the "Information Management Body Of Knowledge" IMBOK does.

IMBOK has two main parts, the knowledge areas and the processes.

The Knowledge Areas:

- Information technology: The domain of technology is frequently changing and it brings special challenges and difficulties to those who would hope to understand it. Therefore, in large organizations, there should be an IT support group that knows all about the different technologies that are being used.
- Information system: a way to make sense of technology is through engineering it into information systems that involve the hardware as well as all the components of a functioning system including the human competence to work with the system in order to deliver outputs. Traditionally, "systems development department" has been carrying out the development and maintenance of Information systems.
- Business processes and Business information: Information systems are applied to business processes so as to improve them, and also to bring data to the business that that turns into useful business information. It is important not to know that business systems are not the same as information systems.
- Business benefit: information technology investments bring benefits to the management of business, but these benefits are not fully understood. Recently, since the appearance and popularization of the Balanced Score Card, interest in business performance management has been significantly increased. Nevertheless, not much thoughtful effort has been made in order to relate business performance management to the possible benefits that information technology investments have to offer as well as the introduction of innovative information systems.
- Business strategy: a lot of organizations attempt to work with a strategy that guides them and provides direction to their efforts, though the quality of typical organization strategies differs extensively. A business strategy is commonly the outcome of senior management considerations.

The Information Management Processes:

- Projects: Information technology is impractical unless it is engineered into information systems that are able to address the needs of the business systems (business processes and business information). Having business people express their needs can be very hard in most cases.
- Business change: The finest information systems succeed in delivering benefits in terms of change attainment within the business systems. Although people do not necessarily enjoy change, particularly when it creates new demands on their skills in the ways that new information systems frequently do.
- Business operations: is referred to business at work: constructing its goods and services, bringing value to customers and others, performing to the expected level, and grossing revenue together with bringing happiness to customers.
- Performance management: is referred to the position where the business strategy encounters business systems and where the benefits of our investment in better business practice are lastly realized and delivered.

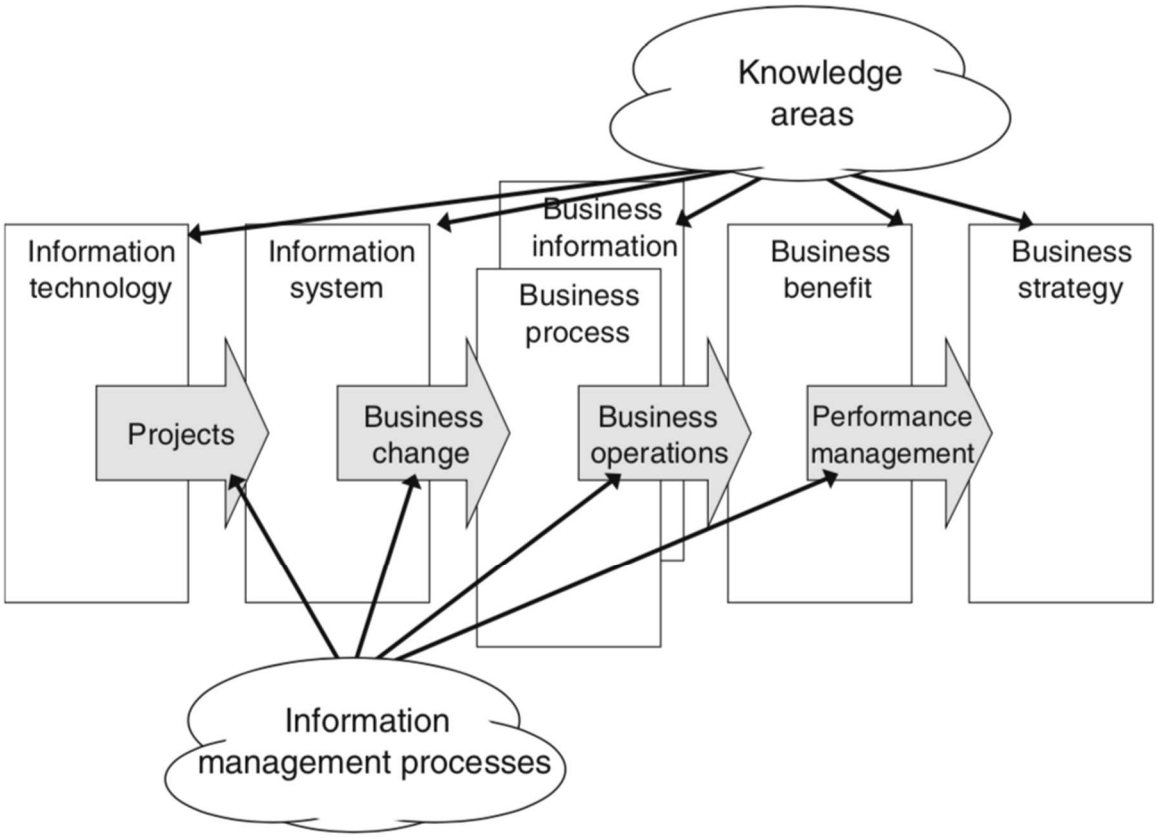

Figure 2: Six management domains and the four intersections of necessary alignment "IMBOK"

Source: (Bytheway, 2015)

2.2 Knowledge Management

According to Bryan Bergeron (2003), the author of Essentials of knowledge management, the ability to selectively capture, archive, and access the best practices of work-related knowledge and decision making from employees and managers for both individual and group behaviors is called the holy grail of knowledge management. But in practice most of knowledge management practices fail to reach their targets, because it's practically impossible to capture the thoughts, beliefs, and behaviors of employees or managers in an efficient way to provide other people or machines with enough inexpensive high quality information so that they could make the same decisions and perform the same complex tasks with the same leadership principles (Bergeron, 2003).

From the business point of view, Bryan Bergeron (2003) defines Knowledge management as follows:

"*Knowledge Management (KM) is a deliberate, systematic business optimization strategy that selects, distils, stores, organizes, packages, and communicates information essential to the business of a company in a manner that improves employee performance and corporate competitiveness*", and goes on by stating that Knowledge Management is "Agnostic" about the type and source of information.

This definition clarifies that basically Knowledge Management is a systematic approach towards managing information and intellectual assets in a fashion that the company would benefit from it in terms of competitive advantage, and it is not limited when it comes to the type and source of the information or the technology (Bergeron, 2003).

J. Liebowitz On the other hand defines Knowledge management simply as: "*Knowledge management is the process of creating value from an organization's intangible assets*." In the practice of knowledge management it is very important not to confuse its aspects, it must be clear what exactly data, information, and knowledge are. According to Liebowitz (2001) most of people tend to confuse information with knowledge, where they should know that information is considered to be "patterned data" and knowledge as "the capability to act" (Liebowitz, 2001).

Bryan Bergeron (2003) believes that the following definitions and concepts clarify the difference between the terms mentioned before:

- **Data:** are just numbers. They are numerical values as results from some calculation, observation or experiment.
- **Information:** is a set of data that are put in a context, in a way that explains or interprets a certain event or process.
- **Metadata:** is information about the information that was used. In other words, metadata is a description about the information, which includes high-level categorization of both data and information.
- **Knowledge:** is a blend of metadata and awareness about the context where the metadata could be successfully applied. Knowledge is organized information to improve the comprehension.
- **Instrumental understanding:** Is the complete and clear idea about something and the ability to relate specific understandings and knowledge to immense concepts.

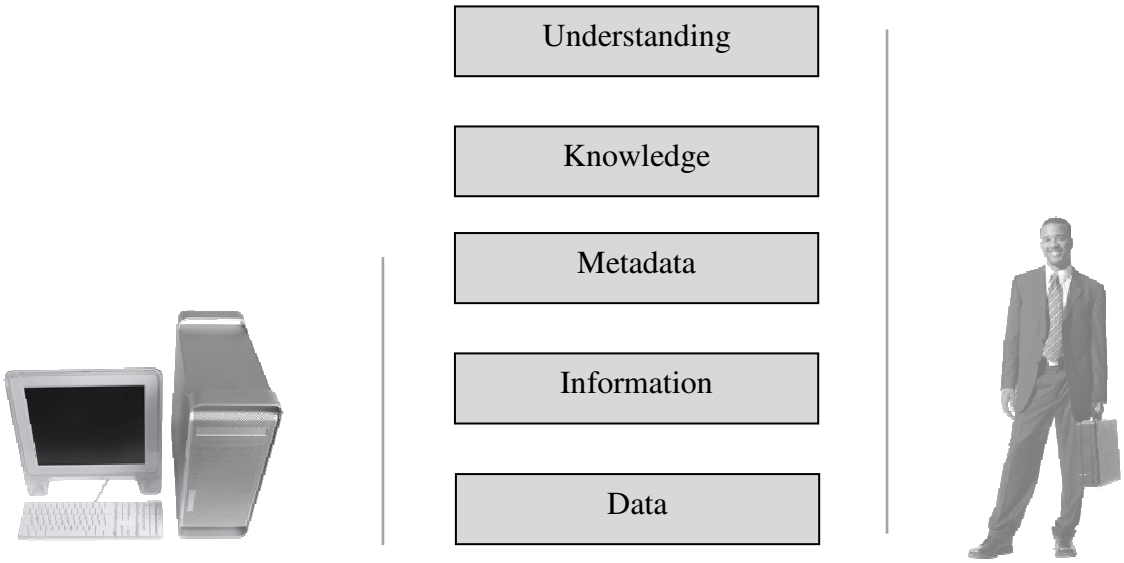

Figure 3: The order of data, information, metadata, knowledge, and understanding

Source: (Bergeron, 2003; Author)

Human capital is considered as one of three major components of Intellectual capital and it includes all the skills, knowledge and abilities of the all the people in an organization. From a knowledge management perspective, human capital is made of three different types of knowledge. Bryan Bergeron (2003) explains them as:

- Tacit: is the type of knowledge that is people's subconscious, things people do which they find difficult how to explain to others.
- Implicit: is also controlled by experts like tacit knowledge but with the difference that it could be extracted from experts with the use of knowledge engineering.
- Explicit: is the type of knowledge that could be transferred from experts to others simply verbally or written as means of communication.

Knowledge management efforts normally have their focus set on organizational objectives for example enhanced performance, innovation, the sharing of lessons learned, competitive advantage, integration and constant improvement of the organization (Markopoulos & Kornilakis, 2016).

The efforts of Knowledge Management overlap with organizational learning and could be distinguished from organizational learning with a better focus on the management of knowledge as a strategic asset as well as an emphasis on encouraging the sharing of knowledge.

It is considered as something that enables of organizational learning and a more tangible mechanism than what has been in the previous abstract research. Figure 4 presents one of the basic knowledge spiral and the major elements that compile the concept (Markopoulos & Kornilakis, 2016).

"*Knowledge management cannot exist without knowledge engineering, and knowledge engineering cannot exist without people*" (Markopoulos & Kornilakis, 2016).

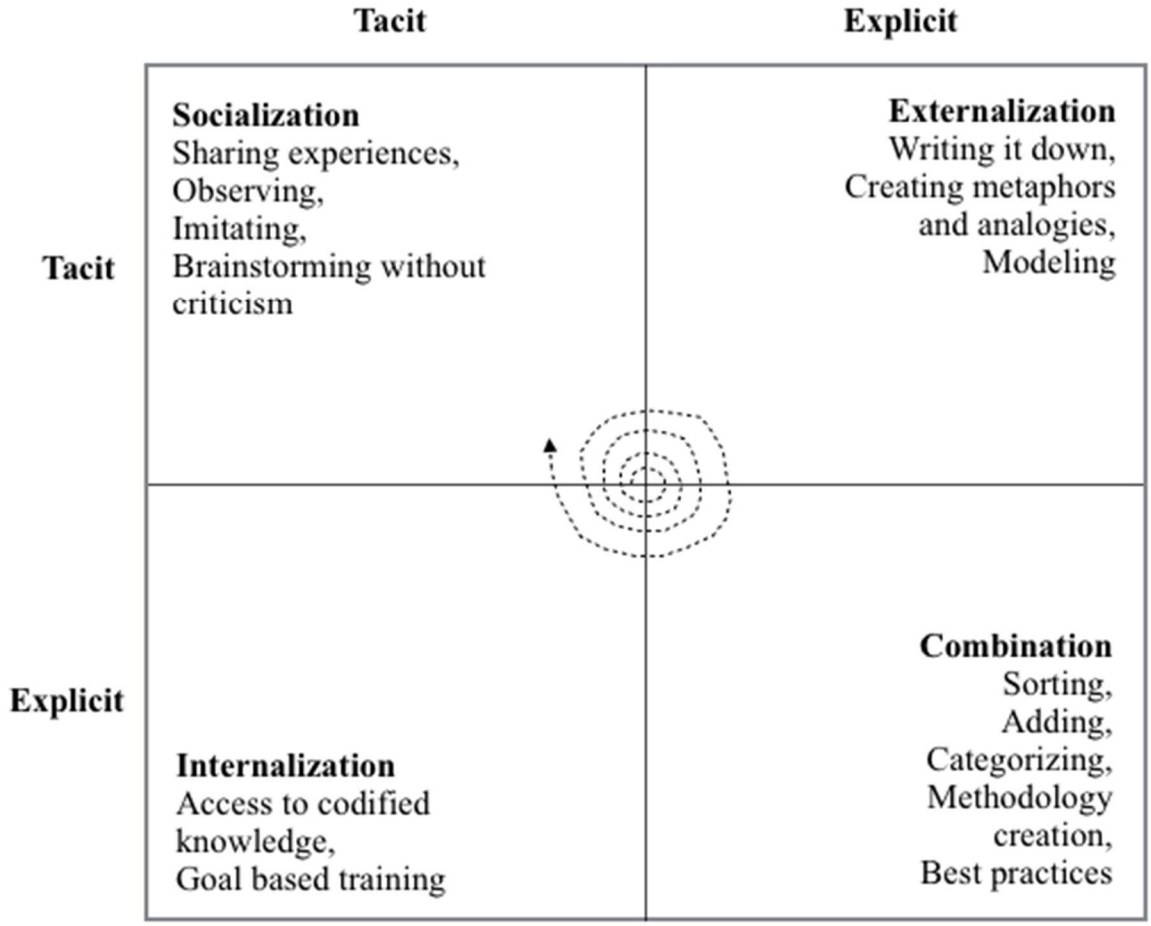

Figure 4: The Nonaka – Takeuchi Model knowledge management model

Source: (Markopoulos & Kornilakis, 2016; Author)

J. Liebowitz (2001) On the other hand refers to them as "various forms of knowledge" and explains some of them slightly in a different way. The author explains tacit knowledge as "the knowledge of subconscious" as almost no thinking is required to do something using this type of knowledge.

J. Liebowitz (2001) believes that the other form of knowledge is more complicated, and more expert and therefore much harder to extract, document, and archive this type of knowledge in the knowledge warehouse. He refers to explicit knowledge as the "more obvious" knowledge, which could be documented easily (Liebowitz, 2001).

Gerhard Fischer and Jonathan Ostwald (2001) call Knowledge management as a cyclic process of three activities: creation, integration and dissemination. They believe that human knowledge activities are supported by computation and manipulation of information, and therefore they explain information repository based on the cyclic process as:

"*An information repository stores information that was created in the past and is disseminated throughout an organization or group*" (Fischer & Ostwald, 2001, p. 60).

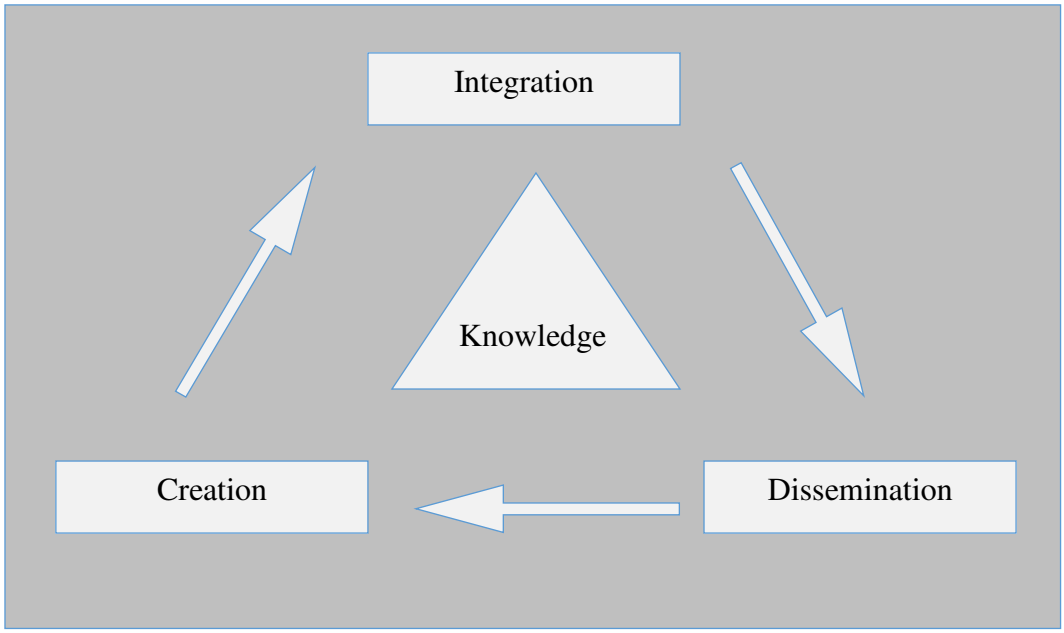

Figure 5: The cyclic process of Knowledge Management

Source: (Fischer & Ostwald, 2001; Author)

Creation: work nowadays is more and more in need and concentrated on information and for that reason knowledge management approaches exist. One assumption that traditional knowledge management approaches have is that the most important issue for workers is to find answers they could apply to their current problem in the organizational memory.

On the other hand, the design-based approach assumes that not all the answers and knowledge would be found within the organizational memory to understand and solve such problems, and for this reason workers must always create new knowledge (Fischer & Ostwald, 2001).

Integration: in traditional knowledge management approaches, knowledge engineers cautiously create a knowledge base and it is updated regularly. In the design-based approach organizational memory (because it is used as both a source of information for workers to better understand the problem, and a repository for new information that was created by the worker as they worked) is evolving constantly to add information and knowledge created during work to it.

Therefore the information and knowledge repositories and organizational memory are actively integrated into the work process as well as social practices of those who created them. However this is not an easy job (Fischer & Ostwald, 2001).

Making the connection between old and new knowledge in a manner that organizational memory would have a better ability to inform work, has been proven challenging for knowledge integration. The knowledge engineers in the traditional approaches of knowledge management performed this task. In the design-based approach however, the users perform this task at the same time they are using the organizational memory.

Knowledge integration has to compare the following tasks: the first task is conceptual generalization, that is relating information from two or more different contexts, and second one is representational formalization, that is to put the information in such a form that it would be possible for computational mechanisms to access and interpret it (Fischer & Ostwald, 2001).

Dissemination: workers are provided by the information that is in the organizational memory to help them solve problems. Traditional knowledge management approaches disseminate knowledge in trainings or as printed reference documents as they assume their work is predictable and repetitive.

In the design perspective however, the information and knowledge workers needs are considered to be unpredictable because the need for the information comes from specific situations where workers have difficulty understanding a problem, so the working and learning is integrated because workers need to learn how to deal with a problem as they work (Fischer & Ostwald, 2001).

The knowledge management literature continually highlights the indivisible relationship among organizational culture and knowledge management (Rahman et al., 2018).

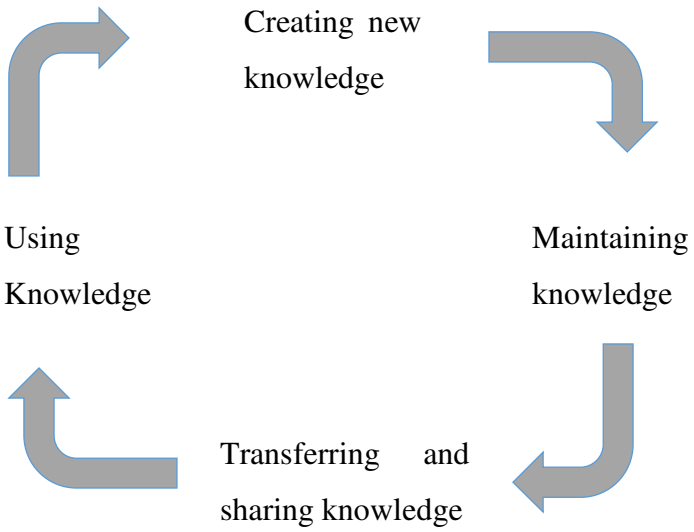

Figure 6: The general model of knowledge management

Source: (Ahmady et al., 2016; Author)

The life cycle of the model above has shaped a pivot ranging from acquisition, organizing to establishing and reusing or spreading knowledge. Acquiring knowledge happens where people spend their time to obtain it. Knowledge components are obtained distinctly and are organized by different technologies. Certain knowledge is acquired through communication between people. People have been the source of knowledge as well as its users and the play a major role in knowledge management. It is imperative that people have contributed in process of sharing knowledge within groups, societies or organizational groups. This model consists of four processes:

1) Creating knowledge: this phase includes activities that are related to entering new knowledge to system and contains knowledge development, discovery, and acquisition.

2) Maintaining knowledge: it has the role of knowledge of stabilizing activities in the system. Meanwhile, authorities highlight organizational memory as a significant factor involving the ability of an organization to maintain the knowledge. If organizations needed to acquire an effective knowledge management, they could not satisfy themselves with the creating and using the organizational memory. Another memory, known as "individual memory, is considered to be as the most important source of hidden knowledge. Knowledge management is more effective when these two types of organizational memory are present together and reinforce each other.

3) Transferring knowledge: it is referred to activities concerning the knowledge transferring process from one to another person or part of organization and involves communications, translation, conversion and interpretation of knowledge. Knowledge is transferred not only by people, but also through automated systems. Sharing knowledge is attributed to its spread and has been chosen for a process by which knowledge is transferred from an individual or group to another.

4) Using knowledge: it is referred to activities that are in relation with knowledge in organizational process. Knowledge is more valuable when it is used. Generally, organizational knowledge has to be used in order to enhance services, processes and productions of an organization. Organizations could face difficulties in term of keeping their competitive advantage if they would not able to identify the correct form of knowledge in its appropriate use in different situations. In today's world, innovation and creativity has become the way to success, thus it is essential for organization to acquire and use the correct type of knowledge in order to be successful (Ahmady et al., 2016).

2.2.1 Artificial Intelligence

Artificial Intelligence (AI) plays a significant role when it comes to development and advancement of knowledge management field. Capture and representation of knowledge is a very important part of knowledge management as it is mentioned before, and this is where the field of Artificial Intelligence is proved to be especially useful (Liebowitz, 2001).

To develop knowledge repositories for knowledge management systems accessible online, some knowledge engineering methodologies (knowledge acquisition techniques such as interviewing, and card sorting) could be used to extract tacit knowledge from experts in order to build expert systems. On the other hand, AI methods (e.g. knowledge discovery and data mining) could be used to create new knowledge by finding out the relationships and trends in the knowledge repositories. To represent the new knowledge in the knowledge warehouses, knowledge taxonomy and knowledge mapping are created in order to work as a foundation on which knowledge repositories are built. AI is typically the field where expert and other intelligent systems are built; by the help of knowledge ontologies and other ways of representing captured knowledge, which are also created in AI field. These AI techniques could be applied in the knowledge management field in order to codify the knowledge within the knowledge management systems (Liebowitz, 2001).

2.2.2 Knowledge engineering

Knowledge engineering came out to be a sophisticated field in the 1990s as a different field from software engineering, however, closely connected to software engineering. From those aspects which are different between knowledge engineering and software engineering, we can name the following: a few knowledge elicitation and modeling techniques, a few protocols for representing knowledge, and a collection of mechanisms and processes for implementing automated reasoning (Preece et al., 2001).

Authors of better knowledge management through knowledge engineering (2001) listed the process of knowledge engineering as follows:

1. Requirements analysis: the scope of knowledge-based system must be identified in the means of expected competency. This means what are the systems capabilities (for example which queries the system would be able to answer).
2. Conceptual modeling: is to create concepts for the application domain based on the previous step and to define terms and constraints including the relationship between them and their usage.
3. Knowledge base construction: to collect knowledge containers and to add instances of domain knowledge to the knowledge base using ontologies or conceptual models from the previous step.
4. Operationalization and validation: to put the knowledge base from step 3 into operation by the use of automated reasoning mechanisms and also to check and validate the competence of the knowledge base according to the requirements mentioned in step 1. Only if system satisfied those requirements then we would be able to release the system, if not however, processes 1 to 4 must be repeated until satisfactory results are achieved.

Refinement and maintenance: after the system is released and delivered, it will contentiously change and evolve because the knowledge changes. Therefore during the lifetime of the system processes 1 to 4 will be continually repeated (Preece et al., 2001).

2.2.3 Knowledge management styles

The interest in implementing knowledge management methods has been increasing lately in companies. However companies' attitude towards starting their knowledge management programs varies. Some companies are holding back on their programs simply because they are afraid of change, but on the other hand they are motivated to start these programs in order to improve their business performance. Knowledge types and competence of the companies are different; therefore managers of these companies have to use different knowledge management methods and they have to align these methods with the corporate culture of their company. Nevertheless, knowledge managers are still facing challenges in using knowledge management methods because sometimes it is not clear how these methods could improve corporate performance (Choi & Lee, 2003).

According to Choi and Lee (2003) earlier studies show that knowledge management methods could be categorized based on the two dimensions of the management focus. The first dimension is focused on the explicit knowledge and the second dimension is focused on the tacit knowledge.

Authors mentioned earlier however categorize knowledge management methods in to four styles based on the explicit-oriented and tacit-oriented perspectives: dynamic, system-oriented, human-oriented, and passive. The tacit-oriented perspective is about gaining and sharing of organizational knowledge by personal communication. The explicit-oriented perspective is about the degree of codifying and storage of organizational knowledge in the organization in a manner to have easy access for employees to use. Based on these perspectives the four knowledge management styles are explained as follows:

Dynamic: companies who have a dynamic style are both integrative and aggressive because they use of both explicit and tacit oriented methods in an extensive manner. These companies are dependent on sophisticated and cultured knowledge; therefore information systems are used in these companies to encourage individuals that are separated by place and time, to work as a team. These companies benefit from proven knowledge and are able to discover more potential (Choi & Lee, 2003).

System-oriented: companies with this style relay more on codifying and reusing knowledge. They use advanced information technologies to have better codification in order to make accessing and using the knowledge less complicated. These companies have a faster response

to their customers and the cost of the knowledge transaction is reduced thanks to their complex and advanced codifying. In these companies organizational effectiveness and better economics could be gained by reusing codified knowledge, which is managed in a formal fashion. Different training programs increase management capabilities; therefore the need for communication and coordination between members of the organization would be reduced (Choi & Lee, 2003).

Human-oriented: the focus of companies with this style is on the gaining and sharing tacit knowledge and experience. Meaningful knowledge is not retrieved form repositories and databases in a simple manner because informal social networks are the source of knowledge where standard procedures could be ignored in order to find better or simpler ways of operating (Choi & Lee, 2003).

Passive: companies that have a passive style basically have little or no interest in knowledge management, thy do not have any interest in using organizational structure or culture nor they do in using information technologies for managing knowledge. Therefore these companies do not benefit completely from knowledge and their effectiveness is gradually reduced (Choi & Lee, 2003).

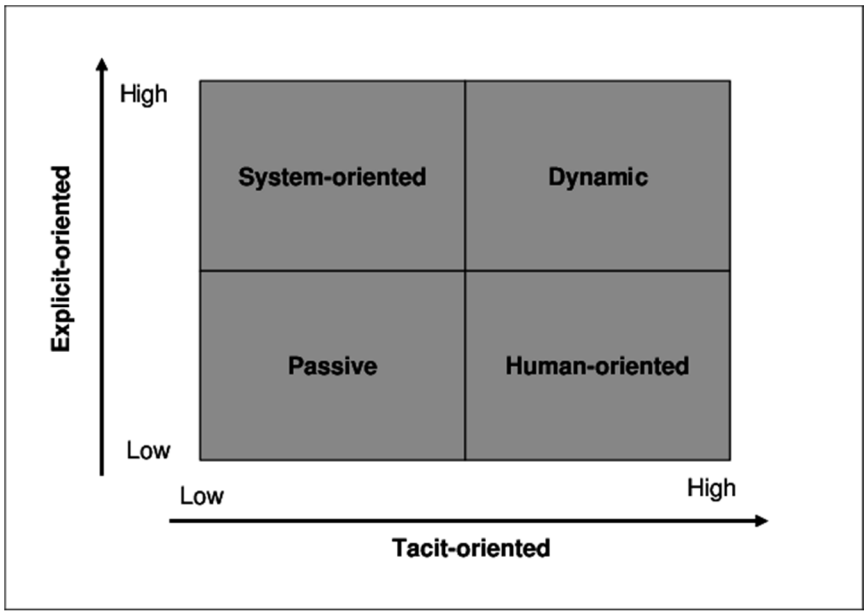

Figure 7: Four styles of Knowledge Management

Source: (Choi & Lee, 2003)

2.2.4 Knowledge strategy planning

Kim, Yu, and Lee (2003) define knowledge strategy planning as follows: "*a process of creating an organizational knowledge vision, designing knowledge management architectures, and organizing a set of activities and resources to implement them"* (Kim, Yu, & Lee, 2003, p. 297).

Knowledge strategy planning has a crucial role when it comes to designing and implementing operational and effective knowledge management. Strategies of knowledge management should be able to help improve organizational performance; in other words, they should increase the efficiency and effectiveness of business processes. During the process of knowledge strategy planning, an organization will find out about its strength, weakness, and opportunities. For knowledge strategy planning some of information systems (strategy) planning principles could be useful but it has some limitations with it comes to the use of its methodology. The reason why information systems planning methodologies could not be applied directly to knowledge strategy planning process is that the nature of knowledge is different than information in the first place (Kim, Yu, & Lee, 2003).

The main reason why knowledge strategy planning is confused with information systems planning is many people cannot distinguish between knowledge and information. Knowledge is created in the human brain by processing and interpreting information. On the other hand information systems planning is about identification and analysis of information but knowledge strategy planning is about the process of creation and justification.

For information similar techniques and processes could be applied to different typed of information, but for knowledge, depending on the type of knowledge the design of knowledge management process is changed. Therefore when it comes to methodologies also it is difficult to use information systems planning methodologies to address knowledge related issues as they are about identifying information and building systems.

A knowledge strategy planning methodology must be able to produce different results based on the type of knowledge in use. "*In knowledge management, the primary subject that takes charge of creating, sorting, interpreting, and utilizing knowledge is a human being, not an information system*" (Kim, Yu, & Lee, 2003, p. 299). For this reason knowledge strategy planning methodologies should be different from those used for information systems planning. Kim, Yu, and Lee (2003) believe that a knowledge strategy planning methodology

has to enable an organization to find out what is their core knowledge and in order to manage it they have to design organizational infrastructures, which serves as a basis for supporting different aspects (human, cultural, administrative, organizational, and technical) of knowledge management (Kim, Yu, & Lee, 2003).

2.2.5 Intellectual capital

In the modern information and knowledge society, it is essential to assess the intangible organizational resources that create long-term value for organizations. Intellectual capital and management of knowledge are among these intangible organizational resources (Atkočiūnienė & Praspaliauskytė, 2018).

The most usual definition of intellectual capital denotes that it contains all knowledge and experience, professional knowledge and skills, association with goals and technological abilities, and its application delivers competitive advantage of the company. Hence, it can be decided that intellectual capital comprises of resources and abilities that are rare and valuable with no substitutes and cannot be copied, which guarantees that organization can accomplish superior performance and sustainable competitive advantage (Zlatković, 2018).

One common definition of intellectual capital in scientific literature is the sum of three interrelated components that are mutually supporting: human capital, structural capital (also known as organizational capital), and relational capital (also known as customer capital) (Atkočiūnienė & Praspaliauskytė, 2018).

Zlatković (2018) states that the most extensively used classification of intellectual capital suggests that it consists of human capital, structural capital and relational capital. Human capital is considered to be the key element of intellectual capital and one of the most prized organizational assets. It is a fundamental property of the organization, since it is a source of renewal of business strategy, creativity, innovation, and hence, it leads to superior competitive advantage. Structural capital contains organizational abilities, processes, patents, trademarks, culture, databases, and includes the knowledge that stays in the company after employees leave. Relational capital comprises of the knowledge that is contained in the processes of identification, development and maintenance of external relationship. The company has access to the knowledge and resources enclosed in and emerged from the network of relationships based on the relational capital (Zlatković, 2018).

Intellectual capital and knowledge management are closely interrelated, because they both include activities that necessitate intellectual effort, preliminary with knowledge creation and ending with knowledge measurement. Moreover, these two areas affect each other and create robust interactive effects on organizational performance and success (Atkočiūnienė & Praspaliauskytė, 2018).

2.2.6 Innovation and Innovative knowledge management

Innovation plays a crucial role in the success of companies and organization, especially in the recent years where companies are faced with the knowledge economy. M. Wang and T. yang (2016) point out that due to volatility and rate of change in the business environments, small- and medium-sized enterprises are facing extraordinary challenges that knowledge economy brings to them, and in order for them to survive, innovation plays a vital role. On the other hand, knowledge management has become a key component considering competitive advantage and for this reason many organizations rely on the knowledge management to improve and enhance their competitiveness by implementing knowledge management. They believe that knowledge management has the potential to increase competitiveness and innovations and therefore leads small- and medium-sized enterprises to a sustainable performance (Wang & Yang, 2016).

In order to have competitive advantage, organizations are constantly trying to be innovative by changing, balancing, reformulating and implementing their growth strategies, preferences, technologies, and etc., and knowledge management is no exception. According to R. Nowacki and K. Bachnik (2016) embracing knowledge management frameworks or its tools in order to have better profits is not quite enough because business environment is very unstable, and customers will not hesitate to change their providers if they wouldn't be satisfied by the purchase experience. Companies always try to be first and would take advantage of their competitors' mistakes; therefore they are always thinking about improving their solutions and/or trying to have innovative solutions that would guarantee their competitive advantage and superiority. Knowledge management is no different in this sense (Nowacki & Bachnik, 2016).

The authors of innovations within knowledge management (2016) however believe that there are no studies in the area between understanding that there is a need for developing

knowledge management systems and the ability to produce innovations. According to R. Nowacki and K. Bachnik (2016) most companies are at the beginning of developing and embracing knowledge management and their efforts towards designing and implementing knowledge management processes are very slow and inflexible. Only about 20 % of companies are planning to implement or actually implementing knowledge management innovations. This might be due to the fact that managers are unaware of the full extent of benefits knowledge management innovations have to offer (Nowacki & Bachnik, 2016).

M. Wang and T. yang (2016) note "*the better the KM qualities of system, knowledge, and services, the more KM use and user satisfaction will be, which can lead to better net benefit.*" They emphasize on system quality by calling it the most significant determinant of knowledge management but On the other hand, as important system quality and knowledge quality are, it is service quality that has the most influence on user satisfaction.

2.2.7 Knowledge transfer

Knowledge transfer is a process that is carried out where one group is touched by the experience of another group since it involves two or more parties together in an organizational context. Knowledge transfer has been conceptualized as the deployment, integration, and use of knowledge resources. Facilitating knowledge is a demanding task due to the fact that the willingness of individuals to share and integrate their knowledge is one of the most common barriers for knowledge transfer. For example, the bureaucratic organizational culture in organizations in public sector tends to mean that employees frequently see knowledge management as a management responsibility and not as responsibility that is for every employee to take. Thus, it is important to investigate how elements of organizational culture organizational socialization influence the knowledge transfer.

Organizational culture could be considered as a main facilitator in constructing a positive knowledge transfer environment. Some other studies regarding this matter reached the conclusions that organizational cultural elements including trust, communication, reward system, and organizational structure could impact knowledge sharing in organizations in a positive way (Rahman et al., 2018).

Although several studies define the success of the transfer process as the degree to which the knowledge is replicated by the recipient unit, others define the scope of transfer success by measuring employees' ownership of, commitment to, and satisfaction with the transferred

knowledge. Therefore, studies of knowledge flows are concerned mostly with the amount of knowledge transferred into and/or from subsidiaries, while the studies on transfer success investigate the extent to which the arriving knowledge is implemented by the recipient units.

Knowledge transfer is regarded as a two-stage process containing of both knowledge inflows and knowledge implementation (Morgulis-Yakushev et al., 2018).

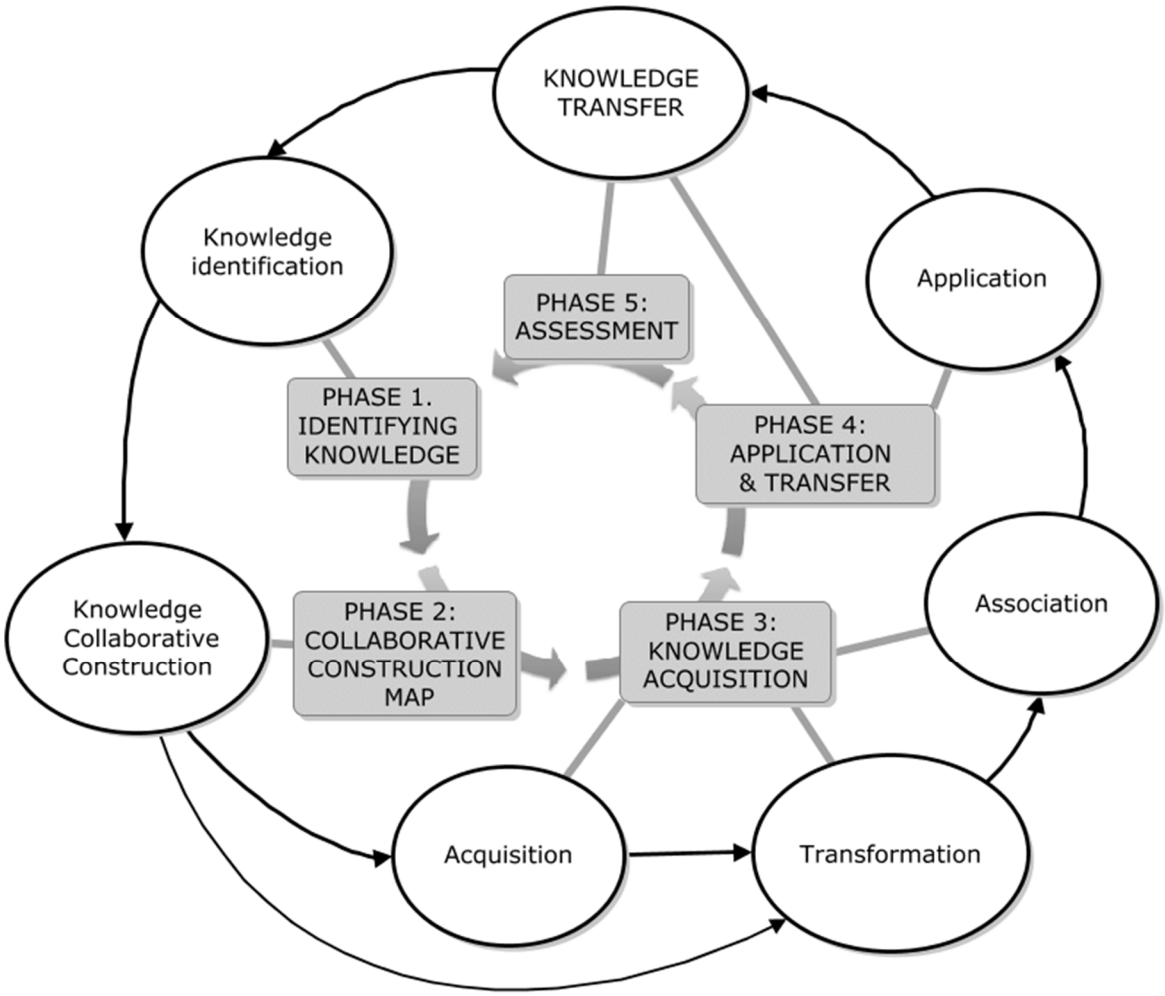

Figure 8: Knowledge transfer Process

Source: (De Benito et al., 2017; Author)

2.3 Organizational culture

According to Armstrong (2006) "*Organizational or corporate culture is the pattern of values, norms, beliefs, attitudes and assumptions that may not have been articulated but that shape the ways in which people in organizations behave and things get done. It can be expressed through the medium of a prevailing management style in the organization.*"

Organizational culture is the shared beliefs, principles, values, and assumptions that form behavior by constructing commitment, providing direction, creating a collective identity, and building a community. An organizational culture could be effective when it is in alignment with the organization's environment, resources, values, and goals (Okatan & Alankuş, 2017).

According to Ahmady et al. (2016) Culture of an organization is comprised of shared beliefs, attitudes, assumptions, and expectations guiding behaviors the law or clear instructions are absent. Ahmady et al. (2016) state "*Culture could be a powerful resource of common identity purpose and flexible guidelines.*" Weak organizational culture stopped people from sharing their knowledge to preserve personal power and their efficiency (Ahmady et al., 2016).

Verdu-Jover et al. (2017) claim that organizational culture has been used and defined broadly as a fairly stable, stable set of values, beliefs, assumptions, and symbols shared in the organization and based on this formation, researchers have conducted studied regarding the relationship among various types of cultures and innovation outcomes. In the contrary, the dynamic systems perspective considers culture as continuously receiving environmental pressures that needs nonstop adaptation; they have an inherent feature of change, which is called adaptive culture (Verdu-Jover et al., 2017).

Companies must assign flexible leaders who provide autonomy to their followers in decision-making and encourage them by demonstrating wanted behaviors and motivating them through intrinsic and extrinsic rewards. On the other hand companies must appreciate leaders who encourage their followers to take risks and take part in knowledge-based activities. Moreover, companies should help their leaders in developing a culture that promotes learning and exchange of new ideas and information. A culture that promotes and rewards learning is able to develop awareness in employees to produce and obtain new ideas and experiment with them. Thus, companies considering excellence in the open innovation paradigm must empower their inspiring leaders to promote a learning culture (Naqshbandi & Tabche, 2018).

The appearance of open innovation models challenges companies to move past their traditional innovation standards and institutions would require to adopt more contemporary approaches to innovation management. Some of leadership styles, such as transactional leadership, directive leadership, and aversive leadership have proven to be acting as barriers to innovation because the aforementioned leadership styles are characterized by control, compliance, low flexibility and low innovation between employees.

According to Okatan & Alankuş (2017) The Competing Values Framework was initially developed from research into the key indicators of effective organizations. Two vast dimensions arose in which the markers were prearranged into the following four main groups: First dimension identifies the effectiveness criterion that highlights flexibility, discretion and dynamism from the criteria that stresses out stability, order and control. Second dimension distinguishes effectiveness criteria that underline internal orientation, integration, and harmony from criteria that emphasize external orientation, diversity and rivalry.

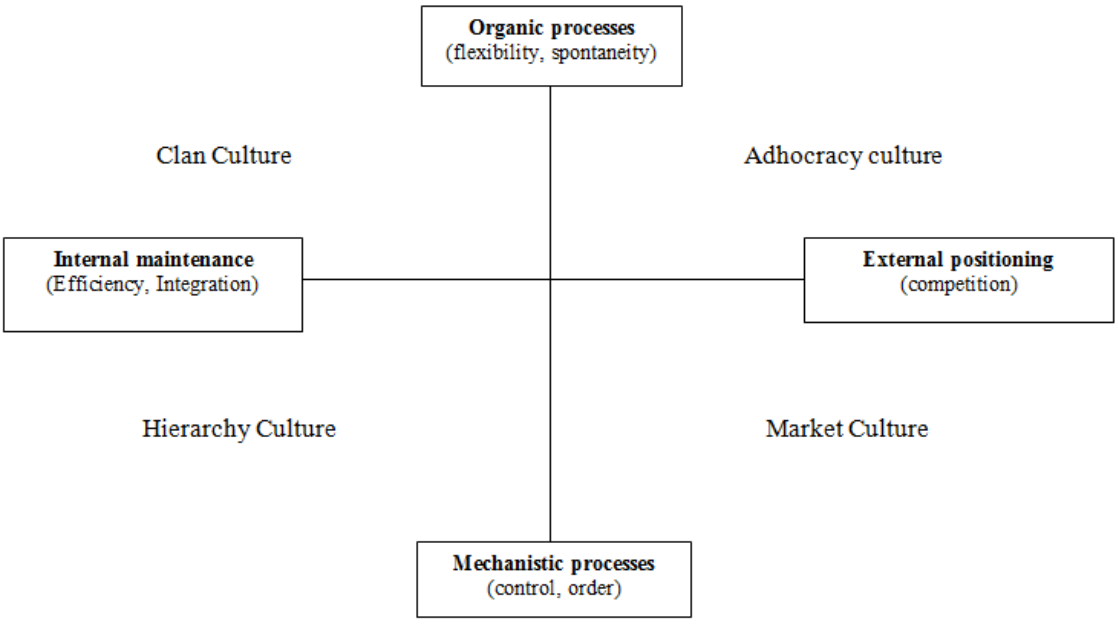

Figure 9: Types of Organizational Culture in the Competing Values Framework

Source: (Okatan & Alankuş, 2017)

The four clusters are as follows:

The Hierarchy Culture: Processes leading what people do in this type of culture. Effective leaders are decent managers and organizers. It is vital to maintain an organization that operates easily. The long-term worries of the organization are stability, predictability and efficiency. The organization is kept together with official rules and policies. Sizeable organizations and government agencies are repeatedly governed by a hierarchy culture as shown by a big number of standard procedures, multi-hierarchical levels and rule reinforcement prominence.

The Market Culture: This form of organization became common when organizations faced new competitive challenges in the late 1960s. This form was founded on very diverse assumptions when it is compared to hierarchy. Organizational researchers have recognized unconventional activities that form the foundation of organizational effectiveness. The most significant of these is believed to be the transaction cost. Marketplace is not synonymous and should not be mistaken with marketing functions or with the consumers on the market. Quite the reverse, it means a type of organization that is able to function as a market itself and it is lead to the outside fairly more than the interior. Suppliers focus mostly on transactions with external selection regions, like customers, license holders, contractors, trade unions and regulators.

The Clan Culture: the third supreme organization is denoted as clan culture, and the reason why it is called a clan is due to its similarity to a family-type organization. Common values and targets have been infused into compliance, cooperation in clan-type firms. They seem to be like a very big family of economic assets. Typical qualities of clan-type companies are teamwork, employee engagement programs, and corporate commitment to employees, before hierarchical rules and processes or competitive profit centers of markets. A clan culture authorizes its employees and enables them to have a better participation, commitments and loyalty, although some of the main assumptions are that the environment is best managed through teamwork and employee development, that the customer is reflected the best partner, and that the organization is considered to be in the process of developing a humane working environment.

The Adhocracy Culture: As the industrialized world moved from the industrial age to the age of current knowledge, the fourth ultimate type of organization surfaced. It is the utmost reactive organizational form to hyper-violent, ever-accelerating circumstances that

progressively represent the organizational world of the twenty-first century. Besides, the quickly decreasing half-life of product and service advantages, diverse sets of assumptions, were developed from the other three organizational forms. These assumptions are that organizations are largely involved in the development of new products and services and making for the future, and that the greatest task of management is to reinforce entrepreneurship, creativity and the environment (Okatan & Alankuş, 2017).

Naqshbandi and Tabche (2018) state that open innovation deals both with the inflows and the outflows of knowledge that involve knowledge "exploration" and "exploitation" and because of that it needs human capital that is capable of selecting, acquiring, transforming and using knowledge for innovative purposes. Thus, open innovation needs those kinds of leaders who are able to effectively manage human capital. Moreover, leaders are required to have faith in their followers and to encourage them to join in innovative activities in order to promote open innovation. Open innovation activities of an organization are understood, decided, and applied by its employees. In this setting, empowering leadership nurtures creativity and flexibility between followers that results in "very high innovation" by followers' development and their self-confidence (Naqshbandi & Tabche, 2018).

Organizations are confronted by changes and need to know how they learn and manage the learning to be influential in comparative market. The way to improve the circumstances of stability of organization is Knowledge management. When this way is implemented successfully in organization, the suitable cultural field has already been prepared the way for this system. Different researches express that knowing these two factors as the most significant requirement is the priority of activities of organizations' mangers, and the stability of organization is guaranteed by planning organizational strategy. Knowledge management includes a mixture of gaining and collecting implicit knowledge with managing intellectual properties.

Examination, altering and generating a suitable and flexible organizational culture could only change interactive pattern between employees and knowledge management has been used as competitive advantage. It has brought many benefits for organizations in individual level as well as organizational level. In individual level, this empowers employees to endorse their skills and experience by collaborating with others and enables them to share their knowledge and learning in order to reach professional development. The benefit in the organizational level is that it is stimulating organizational performance in terms of efficiency, profitability,

quality and innovation. Hence, knowledge management has been considered as appropriate approach towards having competitive advantage (Ahmady et al., 2016).

Okatan and Alankuş (2017) note that the adaptation and application of innovation needs to align with corporate culture in order to reach success. "*Innovation is a multi-dimensional process, including firm culture, internal processes and external environment. Firm culture, internal processes and external environment define the firms' 'innovation capability'*." (Okatan & Alankuş, 2017) The dimensions of organizational culture demonstrate substantial consequences on internal innovation system dimensions. Particularly the 'organizational leadership' seems to be the most prevailing dimension on internal innovation system dimensions. The leaders form the culture of the organization and initiate innovation culture in the organizations. Overall, the leadership approach in the top most innovative companies is based on 'empowering employees' in their business sector (Okatan & Alankuş, 2017).

Innovation has been proven to be vital to the success of an organization and also individual creativity and innovativeness has been proven to be key to organizational level innovation. Organizational climate can have a significant effect on creativity and innovation within organizations. Employees who have the potential to be innovative and creative are most likely to do innovation if they get strong organizational support.

According to Shanker et al. (2017) organizations have to increase their flexibility, responsiveness and efficiency because of the unpredictable nature of global business environment and the strong necessity to respond to challenges faced by competition, both local and international. This means that there is a larger need for constant innovation of not only products and services but also internal processes and behaviors.

Employee knowledge is vital for organizations if they want to innovate and develop a competitive advantage. Thus, it is crucial to know how to create an organizational climate that nurtures innovation between employees.

"*When ideas support and intellectual stimulation exists, the climate for innovation will be strong and provide dynamic opportunities for employees to challenge prior assumptions, reframe problem areas and pursue new ways of doing things, which can pave avenues for improving overall organizational performance"* (Shanker et al., 2017).

The implementation of the Industry 4.0 concept requires participation from top management encouraging comprehensive change management activities and processes for assembling

organizational and production structures in accordance with the needs of the connected value creation. A cooperative, explorative, and entrepreneurial mind-set is a factor for success that is essential to establish among a company's employees, which are considered as the most important resource. Managers must have inclination to persuade employees of the beneficial nature of Industry 4.0 and to address their worries actively. With the apprehension to this fact, employees' training and development should be focused concerning Industry 4.0's specific competencies and skills like data analytics, IT, software, and human-machine interaction know-how.

Wallach (1983) remarks that there are three types of organizational cultures: bureaucratic culture, innovative culture and supportive culture. Bureaucratic, supportive, and innovative cultures have a relationship with employees work performance with different results; and in order to improve employee performance, it is essential to pay attention to an innovative and empowering culture. Innovative culture enhances creativity and results-oriented, stimulation and challenge became the driving performance. Generally organizational culture is closely connected to behavior in the workplace and particularly in individual performance (Sokolová & Mohelská, 2018).

Robbins et al. (2012) states how an innovative culture look like according to Swedish researcher Goran Ekvall and characterizes it in the following way:

• Challenge and involvement: Are employees involved in long-term goals and success of the organization, motivated by them and committed to them?

• Freedom: are employees allowed to define their work and exercise discretion? And do they take initiative in their day-to-day activities independently?

• Trust and openness: Are employees caring and polite to each other?

• Idea time: Do employees have time to elaborate on new thoughts before taking action?

• Playfulness/humor: Is the workplace a fun spontaneous place?

• Conflict resolution: Do employees put the good of the organization before personal interest when they have to make decisions for the resolution of issues?

• Debates: Are employees allowed to freely express their opinions and ideas for further consideration and review?

• Risk taking: Do managers endure uncertainty and ambiguity, and are employees rewarded for risk taking behavior? (Robbins et al., 2012)

2.3.1 The Hofstede's Model

The Hofstede's model of six dimensions of national cultures:

1. Power Distance: is connected with the diverse solutions to the basic problem of human inequality; "*Power Distance has been defined as the extent to which the less powerful members of organizations and institutions (like the family) accept and expect that power is distributed unequally*" (Hofstede, 2011). This arouses cultural characteristics that are fixed in social inequality such as wealth, power and prestige. Cultures that have high PD tend to support an elite social class over the wellbeing of the group. This behavior is also present in the corporate culture. It is usually an elite group of managers who are comprehend to have a superior, unquestionable social standard. Those cultures lean towards being highly hierarchical with deep respect for elders (Cejka & Mohelská, 2017).

2. Uncertainty Avoidance: is connected to the level of stress in a society facing the unknown future and should not be mistaken with risk avoidance. Uncertainty Avoidance "*deals with a society's tolerance for ambiguity*" (Hofstede, 2011). Uncertainty avoiding cultures try to diminish the possibility of unstructured situations by strict laws and rules (Hofstede, 2011). The help of Rules, technology and religion creates controls that will decrease uncertain outcomes in the future. Countries with high Uncertainty Avoidance culture would consequently develop bureaucratic system in order to deal with unanticipated situations with a precisely defined set of rules (Cejka & Mohelská, 2017).

3. Individualism versus Collectivism: "*is the degree to which people in a society are integrated into groups"* (Hofstede, 2011). On the individualist end everyone is more likely to watch out themselves and their immediate family. On the collectivist side we can see that people care more about the group. "*This dimension is bi-polar as it expresses individualism vs. collectivism. The more "collectivist" a country is the less individualism it enjoys*" (Cejka & Mohelská, 2017).

4. Masculinity versus Femininity: is about the split of emotional roles between women and men and the distribution of values between the genders (Hofstede, 2011). The focuses Feminine culture is on relationship, helping others, physical environment. The masculine

culture however is pursuing money, success, advancement and career (Cejka & Mohelská, 2017).

5. Long Term versus Short Term Orientation: this is related to "*the choice of focus for people's efforts: the future or the present and past*."

6. Indulgence versus Restraint: related to the gratification versus control of basic human wants connected to enjoying life.

According to Hofstede (2011) the dimensional model can be also applied at the organizational and occupational levels. Six independent dimensions were identified that could describe the most of the diversity in organizations and they can be used as a framework to describe organization cultures:

1. Process-oriented versus results-oriented

Process-oriented cultures are ruled by technical and bureaucratic routines and procedures but results-oriented cultures are led by a common apprehension for outcomes.

2. Job-oriented versus employee-oriented

Job-oriented culture care for the employees' job performance only but employee-oriented cultures has a big deal of responsibility for their employees' wellbeing.

3. Professional versus parochial

At first, profession gives members their identity, and then they derive their identity from the organization for which they work.

4. Open systems versus closed systems

This dimension points out the usual style of internal and external communication, and how easy outsiders and newcomers are acknowledged.

5. Tight versus loose control

This dimension deals with the degree of formality and accuracy inside the organization; for example banks are expected to have a tight control and advertising agencies loose control.

5. Pragmatic versus normative

This dimension explains the dominant way of dealing with the environment and specifically with customers. Entities that are selling services are more likely to be on the pragmatic (flexible) side and entities involved in the application of laws and rules are more likely to be on the normative (rigid) side (Hofstede, 2011).

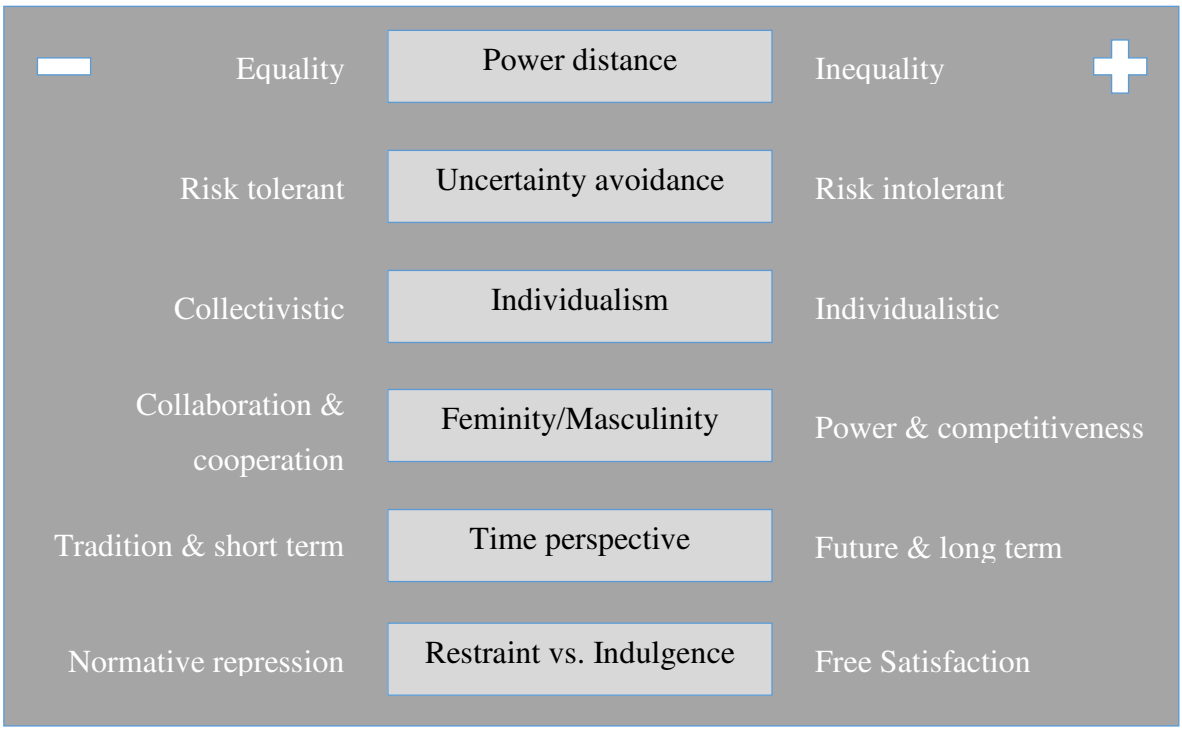

Figure 10: Hofstede's dimensions of culture

Source: (Morente et al., 2017; Author)

2.3.2 Wallach's Model 1983

Ellen J. Wallach has classified organizational culture into three dimensions: bureaucratic, supportive, and innovative; where bureaucratic culture is considered to be a prominent hierarchical organization that is highly organized with a clear line of authority defined. The supportive culture however focuses on interpersonal relationships and it is based on mutual trust, encouragement and co-operation. Innovative culture is considered to be dynamic and it supports creative work, carries new challenges and encourages risky behavior (Wallach, 1983).

The Organizational Culture Index (OCI) questionnaire, also known as Wallach's Questionnaire (1983) is generally recognized, the arrangement of the questionnaire is to analyze the organizational culture level and due to the fact that the parameters in the questionnaire are simple, it is not significantly affected by social and technological development. Use of the Wallach´s Questionnaire tolerates comparing the results internationally and because of its simplicity it is still being used by scholars. Hence, it is possible to verify this method by a simple search in the literature. Searching the well-known and trusted scientific databases such as Scopus and Web of Knowledge that index articles in journals with impact factor, this method has been used by several authors throughout the years. Some of the authors whose most recent articles used this method are mentioned below:

- Mahrous and Genedy (2019)
- Onyemah, Rouzies, and Iacobucci (2018)
- Rhee, Oh and Yu (2018)
- Marbavi, Lumbanraja, Nurbaity Lubis and Siahaan (2018)
- Pawirosumarto, Sarjana and Gunawan (2017)
- Al-Sada, Al-Esmael and Faisal (2017)
- Dextras-Gauthier and Marchand (2016)
- Zhang (2016)
- Xia and Huang (2015)
- Teh, Boerhannoeddin and Ismail (2012)
- Hartnell, Ou and Kinicki (2011)

Therefore it is safe to say that this method is validated and still useful today.

2.3.3 Learning Organization

Learning organization is referred to a type of an organization that improves its capabilities on a regular basis for long term benefits. In other words organizations that adopt learning organization culture must have the proper skills and competences in order to produce, achieve and utilize the knowledge, and transforming individuals as a reflection of obtaining new knowledge and vision (Hussein et al., 2016).

Introducing a learning organization model brings several benefits to organizations. The concept of learning organization is associated with a positive impact on innovation, improving performance in organizations, gaining competitive advantage and maintaining competitiveness (Hussein et al., 2016).

"*In general, learning organization culture was proved to have positive relationship with organizational innovativeness*" (Hussein et al., 2016).

In the 21st century, organizations are supposed to be able to learn and respond quickly. Such organizations should be led by those kinds of managers who are able to effectively challenge conservative wisdom, manage the organization's knowledge base and to enforce the necessary changes. Therefore, these organizations have to be learning organizations, those ones that have developed the capacity to learn, and are able to adapt and change constantly (Robbins et al., 2012).

Table 1: Learning organizations versus traditional organizations

	Traditional organizations	Learning organizations
Attitude towards change	If it is working, don't change it	If you are not changing, it won't be working for long
Attitude towards new ideas	If it wasn't invented here, reject it	If it was invented or reinvented here, reject it
Who's responsible for innovation?	Traditional areas such as R&D	Everyone in the organization
Main fear	Making mistakes	Not learning, not adapting
Competitive advantage	Products and service	Ability to learn, knowledge and expertise
Manager's job	To control others	To enable others

Source: (Robbins et al., 2012; Author)

Learning has to become an integral part of the whole work process; work and learning are interconnected in the process of continual improvement. The learning organization must not rely on learning as a by-product of routine work but is actively supported, facilitated, and rewarded. Interaction between individuals is then considered as a key aspect of organizational learning (Yadav & Agarwal, 2016).

2.4 Industry 4.0

In the late 18th century the 1st industrial revolution happened when mechanical production facilities were powered by utilizing water and steam. The 2nd industrial revolution occurred in the early 20th century when mass production was presented by means of electrical energy and depending on the division of labor. The 3rd industrial revolution took place when information technologies and electronics were employed for automation of production in beginning of 1970s. The concept of Industry 4.0 (Industrie 4.0) which originated in Germany, and it is based on the use of Cyber-Physical Systems (CPS), is considered to be the description for the 4th industrial revolution (Ziaei Nafchi & Mohelská, 2018b).

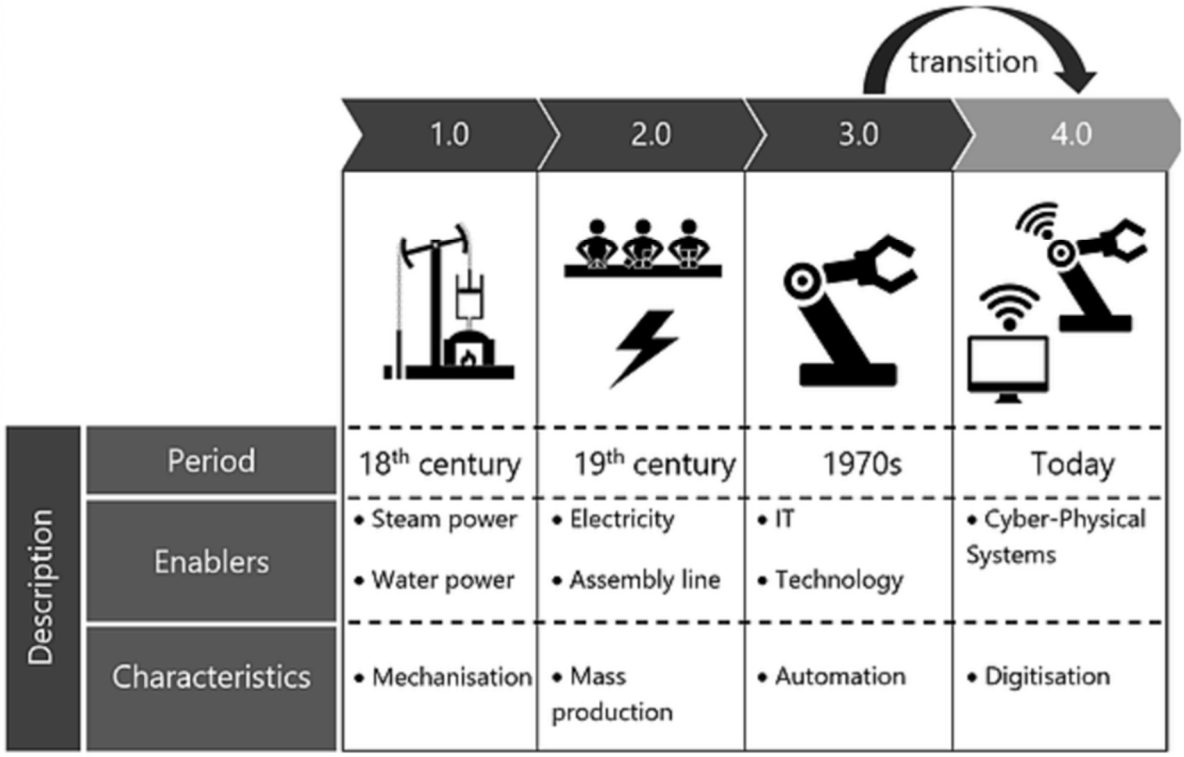

Figure 11: Towards Industry 4.0

Source: (Nowotarski & Paslawski, 2017; Author)

"*Industry 4.0 concept can be characterized as a transformation of production as separate automated factories into fully automated and optimized manufacturing environments. Production processes are linked vertically and horizontally within enterprise systems*" (Kopp & Basl, 2017). Industry 4.0 is which is believed to be the essence of the fourth Industrial revolution, is currently being used in manufacturing by utilizing cyber-physical systems (CPS) in order to grasp high levels of automation (Ziaei Nafchi & Mohelská, 2018a). The Cyber-Physical System (CPS) is the foundation for smart factories and interconnect sensors, machines and IT systems within the value chain across enterprise boundaries (Kopp & Basl, 2017).

The concept of Industry 4.0 can be described generally as a transformation of production as single automated factories into fully automated and optimized manufacturing environments, where production processes are connected vertically and horizontally within enterprise systems (Basl, 2018).

Automation is normally acting, operating, or self-regulating without the human intervention. In other words it could be defined as the cancellation of human intervention partially or completely in the implementation of industrial, administrative, scientific, or household tasks (Mohelská & Ziaei Nafchi, 2018).

"The platform Industry 4.0 itself has divided its main areas of focus across five different working groups up: Reference Architecture; Standardization; Research and Innovation; Networked Systems Security; Legal Environment; and Work, Education/Training" (Frolov et al. 2017).

Industry 4.0 requires substantial investment from the beginning, and therefore a larger interest of companies in industry 4.0 would probably be initiated by government incentives or subsidies (Kopp & Basl, 2017).

Industry 4.0 defines the organization of production processes which are based on interacting technologies and devices, in other words, a 'smart' factory where physical processes are controlled by computer-driven systems and make decentralized decisions which are relying on the self-organization mechanisms (Frolov et al. 2017).

Most of the businesses that are considering Industry 4.0 believe that this trend is not important for them these days. The reason behind this could be because these businesses are uninformed or poorly informed about the potential benefits and impacts of implementation Industry 4.0 (Kopp & Basl, 2017). Thanks to Industry 4.0, it is possible to produce things that are unique in terms of excellent quality and at a price matching the price of mass-produced goods (Nowotarski & Paslawski, 2017).

Odważny et al. (2018) point out the main advantage of the Smart Factory concept as "*the high level of process standardization, due to which the production process remains stable while maintaining a high level of flexibility and agility*" (Odważny et al., 2018). However, Industry 4.0 is mainly beneficial in highly developed countries in terms of competitive advantage, but high levels of automation could cause unemployment (Ziaei Nafchi & Mohelská, 2018a).

Smart Factories have some disadvantages of course, for example high costs, lack of awareness between people who are involved in implementation, insufficient technology and incapability to secure data correctly (Odważny et al., 2018).

Industry 4.0 and its influence in the manufacturing sector are well studied and documented, but the same couldn't be said for the service sector, and the service sector is facing some challenges such as mass customization, digital enhancement, smart work environment, and efficient supply chain (Shamim et al., 2017).

According to Nowotarski & Paslawski (2017) the main features of Industry 4.0 are as follows:

- Interoperability: cyber-physical systems (work-piece carriers, assembly stations and products) allow humans and smart factories to connect and communicate with each other.
- Virtualization: linking sensor data with virtual plant models and simulation models creates a virtual copy of the Smart Factory.
- Decentralization: ability of cyber-physical systems to make decisions of their own and to produce locally thanks to technologies such as 3d printing.
- Real-Time Capability: the capability to collect and analyze data and provide the derived insights immediately.
- Service Orientation.
- Modularity: flexible adaptation of smart factories to changing requirements by replacing or expanding individual modules.

Odważny et al. (2018) describes the purposes of Industry 4.0 are as following:

- Facilitating cooperation and communication of people and machines with the information and communication technology systems actual time.
- Production of separate and customized items, manufactured in smaller production batches in Smart Factory, with the help of high automation and efficiency.
- Facilitating a flexible, efficient and eco-friendly production process in a way to be in compliance with high quality and low cost.
- Reaching a worldwide network of setting values, influencing business models and corporate structure.
- Presenting devices to production process in order to enable system management in a way that is both flexible and dynamic, considering the importance of a customer.

Theoretically, implementing digital transformation and Industrie 4.0 concepts is progressively important for manufacturing companies performing in dynamic and competitive markets; but when it comes to practice, these organizations face difficulties with implementing such concepts because Industrie 4.0 is more a concept than a ready-to-implement solution.

On top of that the complexity of Industrie 4.0 delays implementing Industrie 4.0 systems successfully in a way that they truly incorporate all organizational features and levels (Issa et al., 2018).

Odważny et al. (2018) suggest the following three implementation phases to be distinguished within company:

- Aspiration phase,
- Maturity phase,
- Smart factory

Table 2: The evaluation of Smart Factory

Implementation phase	Evaluation area	Feature	Characteristic
Aspiration	Human factor	Staff qualifications	Team has qualified individuals including IT specialists and automatics engineers.
	Technical / organizational	Cooperation, communication skills	Individuals are capable to work in teams.
		Financials	Budget is sufficient for investments into staff and technology.
	Management	Data	Enterprise aspires to aggregate available data effectively.
		Machine park equipment	Sufficient technology is available: including IT solutions.
		Tools and technologies	Automation and robotics of single processes. Part of the machine park is equipped in PLC steering.
		Vertical integration	Readiness to cooperate with other departments, within enterprise.
Maturity	Human factor	Staff qualifications	Operational employees have analytic skills and operate with available IT software.
		Cooperation, communication skills	Teams gain autonomy and can easily cooperate with others.
	Technical/ organizational	Data	Software and systems are fully integrated data wise. Enterprise is implementing Big Data concept.
		Tools and technologies	Internet of Things is implemented gradually. More elements are included in the net. -Simulation models are used in decision process and production steering. -RFID (or similar technology) is widely used in the factory for track and trace. -Monitoring and cooperation is built within machine park.
	Management	Vertical integration	Full cooperation between departments.
		Horizontal integration	Readiness to cooperate with other companies in the supply chain and potential co-operators.
Smart Factory	Human factor	Staff	No operational employees in the machine park. Staff consists of expert. Employees are controlling the process and react to system warnings if necessary.
	Technical/ organizational	Data and its correctness	World class in aggregation, analysis and data interpretation. -Aggregated data is effectively stored. Data is valid, up to date and allows sufficient production steering.
		Tools and technologies	Full integration of all installed tools and technologies.
		Research and development	Big investment pressure in research and development area. -Staff is being moved to such departments from the shop floor if possible (skills and knowledge wise).
		Virtualization	Simulation models used for all decision required processes.
		Real-Time Capability	Monitoring of current state and real-time capability.
		Safety	Data base is fully secured.
		Horizontal and End-to-End integration	Factory as an integral element of a supply chain cooperating with companies within the branch and also outside.
	Management	Client	High level of integration with clients. Products highly customized according to market demand
		Organizational structure	High level of autonomy and decentralization.
		Control	Demand driven planning according to single clients' orders.

Source: (Odważny et al., 2018)

Implementing the Smart concept needs adequate resources, competent and skilled staff and well-organized processes, which are appropriately flexible and innovative (Odważny et al., 2018).

Smart Factories move their staff from production to other departments where is safer and less hazardous for their health as the production is usually least safe area within factory. On the

other hand this has the benefit of decreasing the possibility of human error and therefore it stabilizes the production process even more. This way their staff could be involved in decisions and managing processes, and are able to focus on research and development (Odważny et al., 2018).

Shamim et al. (2017) note that mass customization, effective and efficient supply chain, getting appropriate information of customer needs and wishes, smart work environment, and the right blend of products and services are the main challenges for businesses in the Industry 4.0 environment. Industry 4.0 needs flexible processes and highly efficient supply chain structures. Furthermore, it requires better management of products, especially in time production, and a more efficient time to market. These are real issues and are very challenging for Industry 4.0, but so are the development, training, and the management of people according to the Industry 4.0 environment and requirements. Unfortunately this issue is very much ignored by the researchers and most studies prefer to address the technological aspects. Another issue ignored by researcher is the service sector as most of the studies focus on only manufacturing firms. Issues such as supply chain efficiency, Internet of things (IoTs), digital enhancement, smart work environment, and mass customization of services are considered to be in the service sector (Shamim et al., 2017).

2.4.1 Maturity Models and Readiness

The Capability Maturity Model (CMM) is considered to be the most recognized model in the field of information systems (Issa et al., 2018). The term “maturity” generally denotes to a “state of being complete, perfect, or ready” and suggests some progress in the development of a system (Schumacher et al., 2016). The Capability Maturity Model was designed with the intention to assess and evaluate the development of software systems as well as some other related areas like project management, human resources management and IT governance. The main assumption of this model is that the performance of the organization would be correspondent to its maturity level (Issa et al., 2018). Maturity models are usually used as a tool to conceptualize and measure maturity of an organization or a process concerning some specific target state. For the purpose of facilitating various analyses of Industry 4.0 maturity, the suggested model contains an overall of 62 maturity items, which are gathered into nine company dimensions. Table 3 shows an overview on the dimensions collected with some exemplary elements in order to upkeep better understanding (Schumacher et al., 2016).

Table 3: Dimensions and maturity items of Industry 4.0 Maturity Model

Dimension	Exemplary maturity item
Strategy	Implementation I40 roadmap, Available resources for realization, Adaption of business models, …
Leadership	Willingness of leaders, Management competences and methods, Existence of central coordination for I40, …
Customers	Utilization of customer data, Digitalization of sales/services, Costumer's Digital media competence, …
Products	Individualization of products, Digitalization of products, Product integration into other systems, …
Operations	Decentralization of processes, Modeling and simulation, Interdisciplinary, interdepartmental collaboration, …
Culture	Knowledge sharing, Open-innovation and cross company collaboration, Value of ICT in company, …
People	ICT competences of employees, openness of employees to new technology, autonomy of employees, …
Governance	Labor regulations for I40, Suitability of technological standards, Protection of intellectual property, …
Technology	Existence of modern ICT, Utilization of mobile devices, Utilization of machine-to-machine communication, …

I40…Industry 4.0, ICT…Information and Comm. Technology

Source: (Schumacher et al., 2016)

"An enterprise achieving a high degree of maturity in industry 4.0 will be the smart enterprise that will offer smart products and smart services to be delivered in an intelligent manufacturing environment in a smart economy" (Basl & Doucek, 2018).

In the research conducted by Issa et al. (2018) they define four maturity levels based on: if deploying the project (particular project investment) within the organization could follow a path that is integrative and cross-departmental; and The degree to which the transformation could be extended outside the organization. These four maturity levels are:

Level 1: No Industry 4.0 or only “ad-hoc”: There is no vision formulated concerning Industry 4.0 or digital transformation and there is no one responsible for that. Therefore, there are no precise processes or supporting systems for them.

Level 2: Departmental level: digital transformation is considered as a technical problem or as a production problem that is being dealt with on a departmental level. However, there is no universal vision towards coordinating and synchronizing such activities. Mostly the IT department or production/engineering departments are among the first to check out the adoption of digital transformation and Industrie 4.0.

Level 3: Organizational level (cross-departmental): Digital transformation is dealt with as a business setback that requires a general vision and integrative approach. All of the departments in the organization have a role in defining this vision and formulating the digital strategy.

Level 4: Inter-organizational level: Digital transformation is considered as a business issue that covers the total value/supply chain. Therefore, defining the digital transformation/Industrie 4.0 vision and strategy must include the complexity and requirements of the value/supply chain partners. The processes and use cases are described in a way that goes outside the organizational boundaries in order to allow collaboration with those partners. This will let the transparency and intelligence that is needed to empower the appropriate decision-making concerning production and/or products (Issa et al., 2018).

According to Lak & Rezaeenour (2018) each maturity level contains a variety of background processes that shows an organization concentration of attention for improving their processes. “*Maturity models can be considered as a structured collection of elements in which certain aspects of the capability maturity in an organization are described*” (Lak & Rezaeenour, 2018).

Basl (2018) notes “a company always operates in a certain environment that, in a number of cases, is conditioned and decisive for its digitization and, in general, the ability to innovate.” Furthermore it is essential to look at it from the perspective of its environments from a “macro” national level and not merely from the “micro” point of view or the firm.

Basl (2018) believes that the “macro” view covers the entire of society, or each state separately and lists the best-known readiness indexes as:

- NRI (Networked Readiness Index)

- GCI (Global Competitive Index)
- Score from the OECD Scoreboard
- Industry 4.0 Readiness Index by Berger (Model, 2018)

In another article Basl & Doucek (2018) present a table with the main "macro" readiness indexes.

Table 4: Main "macro" readiness indexes

Index	Name of index	Authority	Number of indicators	Number of countries evaluated
NRI	Networked Readiness Index	WEF World Economic Forum	51	139
GII	Global Innovation Index	Cornell University, INSEAD, WIPO	81	127
SITS	Science, industry and technology Scoreboard	OECD	200	31
RBI	RB Industry 4.0 Readiness Index	Rolland Berger	2	24

Source: (Basl & Doucek, 2018)

Basl & Doucek (2018) state that at the "micro" level, the readiness of the companies is basically an evaluation or assessment of the maturity degree of the company so readiness models (maturity models) predominate. These are the maturity models they have obtained by reviewing the literature:

- RAMI 4.0 (The Reference Architectural Model Industry 4.0) from BITCON VDI/VDE, ZVEI (Germany), 2015 (Koschnick, 2015).
- Industry 4.0 Component Model – derivate from RAMI 4.0 and oriented on information technology (Koschnick, 2015).
- SIMMI 4.0 (System Integration Maturity Model Industry 4.0) from TU Dresden and TU Heilbronn (Germany), 2016 (Leyh et al., 2016).
- IMPULS (Industry 4.0 Readiness) from VDMA and RWTH (Germany).
- APM Maturity Model Asset Performance Management Maturity Model from Capgemini (Dennis, 2017).

- Industry 4.0 Readiness Evaluation for Manufacturing Enterprises from Academy of Science Hungary (Hungary), 2017 (Halenár et al., 2016).
- Digitalization Degree of Manufacturing Industry from Uni Erlangen (Germany), 2017 (Bogner et al., 2016).
- Stage maturity model in SME towards Industry 4.0.
- Roadmap Industry 4.0 from Uni Caphenberg, 2017.
- Industrie 4.0 MM (Assessment model for Industry 4.0) from Uni Ankara (Turkey), (GOkalp et al., 2017).
- M2DDM (Maturity Model for Data Driven Manufacturing) from Uni Stuttgart (Germany),
- 2017.
- Industry 4.0/ Digital Operation Self-Assessment from Price Waterhouse Coopers, 2016.
- The Connected Enterprise Maturity Model from Rockwell Automation, 2014.
- Pathfinder 4.0.
- Industrie 4.0 Maturity Model from Acatech Studie.
- Firma4.cz from the Czech Minister of Industry and Trade (Czech Republic), 2016.

In an earlier study however Schumacher et al. (2016) listed the following models for assessing maturity or readiness with regard to the domain of Industry 4.0:

- IMPULS – Industrie 4.0 Readiness (2015)
- Empowered and Implementation Strategy for Industry 4.0 (2016)
- Industry 4.0 / Digital Operations Self-Assessment (2016)
- The Connected Enterprise Maturity Model (2014)
- I 4.0 Reifegradmodell (2015)

Basl and Doucek (2018) mentioned three of the models listed by Schumacher et al. (2016) but they decided to leave out the other two models, Empowered and Implementation Strategy for Industry 4.0 (2016), and I 4.0 Reifegradmodell (2015).

Colli et al. (2018) believe that "*The transformation of the manufacturing sector towards Industry 4.0 is setting the scene for a major industrial change. Currently, the need for assisting companies in this transformation is covered by a number of maturity models that assess their digital maturity and provide indications accordingly.* "

Nevertheless, there is a necessity for making the assessments that are company-specific to be able to provide operational recommendations to various companies. Therefore, Colli et al. (2018) provided a design of a new digital maturity assessment approach named 360 Digital Maturity Assessment, which is based on the Problem Based Learning (PBL) model.

Table 5: Industry 4.0 maturity models

Model name/ reference	Maturity stages	Dimensions	Comments
SIMMI 4.0 Leyh et al (2016)	Five stages: 1. Basic digitization level 2. Cross-departmental digitization 3. Horizontal and vertical digitization: 4. Full digitization 5.Optimized full digitization	Four dimensions: 1. Vertical integration 2. Horizontal integration: 3. Digital product development 4. Cross-sectional technology criteria	- Focus on the IT landscape - General activities enabling stage transitions are presented
Schuemacher et al. (2016)	Likert-scale reaching from 1- "not distinct" - to 5 - "very distinct" -.	Nine company dimensions, further detailed into 62 maturity items: 1. Strategy 2. Leadership 3. Customers 4. Products 5. Operations 6. Culture 7. People 8. Governance 9. Technology	- General questionnaire
ACATECH Schuh et al (2017)	Six stages: 1. Computerization 2. Connectivity 3. Visibility 4. Transparency 5. Predictive capability 6. Adaptability	Four dimensions (Industry 4.0 capabilities), each one defined by two principles: 1. Resources 2. Information systems 3. Organizational structure 4. Culture	- Capabilities are examined for each area of the company - Questionnaire combined with visits
IMPULS Lichtblau et at (2015)	Six stages: 0. Outsider 1. Beginner 2. Intermediate 3. Experienced 4. Expert 5. Top performer	Six dimensions which are further detailed into 18 fields: 1. Strategy and organization 2. Smart factory 3. Smart operations 4. Smart products 5. Data-driven services 6. Employees	- On-line self-assessment - Actions for stage transition are presented

Source: (Colli et al., 2018)

2.4.2 Organizational flexibility and innovations

According to Shamim et al. (2017) Industry 4.0 requires an "organic" organization design, which is not very official with flexible rules and policies desires decentralization, empowerment of employees, cooperative teamwork and horizontal communications. "*Innovation capability in a changing environment is more compatible with an organic design of organization*" (Shamim et al., 2017).

Transparency and interconnection of processes leads to optimization of the economic perspective of Industry 4.0, and also leads to some increase in the efficiency, flexibility, quality, and customization. Smart manufacturing technologies, new value propositions, and increased demand orientation that enables load balancing, empower such things like transparency and interconnection of processes (Müller et al., 2018).

Organizational openness and accessibility of information could be considered as precondition for openness and transparency. Every day there is more demand from the society to access public information to prevent corruption, government's abuse of power, theft and fraud, favoritism, abuse of discretion, embezzlement, and nepotism (Ziaei Nafchi et al., 2018).

The need of Industry 4.0 for flexibility in the organizational structure is in accordance to the needs of the situation (Shamim et al., 2017).

Ghobakhloo (2018) believes that manufacturers must get on board with Industry 4.0 sooner rather than later because it's not just an idea anymore. Nevertheless there is a need for development of a detailed strategic roadmap in order to have a successful transition from traditional manufacturing into the Industry 4.0. Though, there is no universal strategy that is suitable for all businesses or industries. The Industry 4.0 roadmap for every company is individual and must be planned based on company's core capabilities, motivations, goals, and priorities.

Nowadays, small and medium-sized enterprises (SMEs) are the foundation of most economies and by providing them with the right tools and support they have the potential to become the basis of sustainable economic growth. SMEs have to constantly adapt both in products and production to be able to stay competitive. SMEs to tackle these challenges with the help of approaches connected to the vision of Industrie 4.0 (I4.0) and Smart Factories (Issa et al., 2017).

"*The development of industry is accompanied by growth in scientific and research activities. It contributes to formation of the new knowledge bases and new industries. It also facilitates to emergence of innovations and inventions within the country*" (Frolov et al. 2017). According to Lavalle et al. (2017) education needs to adapt to the changed conditions and should perhaps re-consider the existing models of teaching aligning it with the potential of digitization. They believe that the using new didactic methods and the utilization of multimedia and technological solutions are already significant factors that have been developed in the e-learning sector and offer numerous connections with the most important aspects related to Industry 4.0; For example as virtual laboratories, video-based learning, augmented reality, communication and collaboration in virtual environments (Lavalle et al., 2017).

The key to success in an uncertain environment such as Industry 4.0 is training, learning, and innovation capability. Organizational training, learning, and innovations are profoundly dependent on the role of employees in the organization and for this reason organizations must formulate their strategies according to what they want and expect from their employees (Shamim et al., 2017).

Each of the challenges of Industry 4.0 requires continuous innovation and learning, which is dependent on the enterprise's capabilities and the people. Suitable management approaches can play an essential part in the development of dynamic capabilities, and an effective learning and innovation environment (Shamim et al., 2017).

2.5 Managerial approaches and methods

According to Shamim et al., (2017) it is widely known that in order to be successful in the environment of Industry 4.0, organizations have to take things such as training, learning, knowledge management, and innovation capability, seriously and pay enough attention to them.

This could be concerning the implementation of cyber physical systems, differentiation, reengineering of products or services, or even building a more effective and efficient supply chain. So as to sustain smartness, innovative capability, and performance, organizations must have creative and innovative employees who are able to work in such smart, uncertain, and competitive environments as Industry 4.0. Growth of the workforce fitting to the requirements and conditions of Industry 4.0 requires applicable management practices. In a larger

standpoint, management means getting things done by the people, but it is not as simple as it sounds.

Managers have to adapt to the managerial practices in accordance to the environment and anticipated results. The environment of Industry 4.0 necessitates learning, knowledge management, and innovation capability, which can enable the technology acceptance as wider results, such as digital improvements and the implementation of CPS. It is comprehensible that in Industry 4.0, organizations are facing a lot of social, technological, and economic challenges. Active competences and innovative employees are required to face the before mentioned challenges.

The environment of Industry 4.0 is unstable and uncertain, and thus needs a high level of technology tolerance for digital developments and implementation of CPS, and technology acceptance can be improved by learning, effective knowledge management, and innovative capability, at the individual level as well as the organizational level (Shamim et al., 2017).

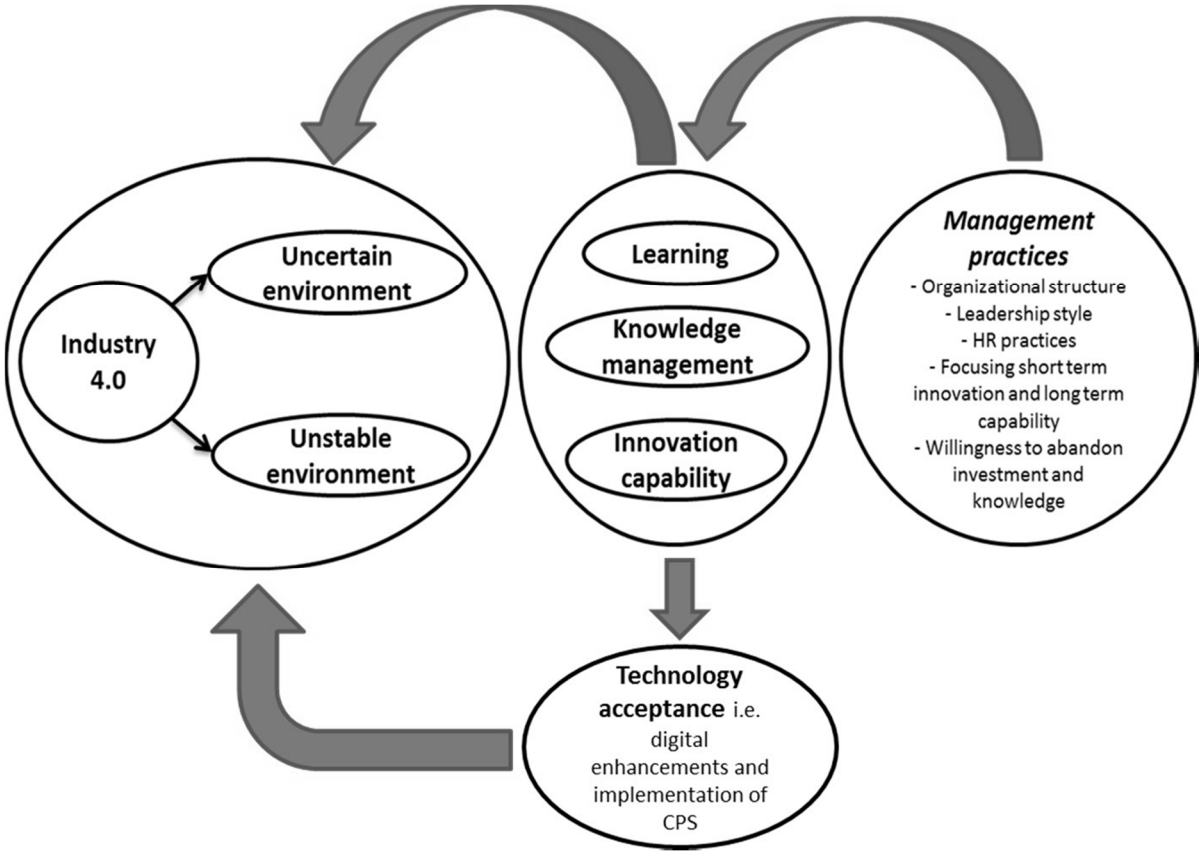

Figure 12: The conceptual framework

Source: (Shamim et al., 2017)

Contemporary approaches

Several features of the previous approaches to management theory remain to influence how managers manage. Most of these previous approaches fixated on managers' concerns inside the organization. In the early 1960s, management researchers started to look at what was happening in the external environment outside the borders of the organization. Two current management perspectives known as systems approach and contingency approach are part of those researches (Robbins et al., 2012).

The systems approach states that an organization takes in inputs (resources) from the environment and converts or processes these resources into outputs that are allocated into the environment. It aids us to better understand management, since managers have to make sure that all the interdependent entities are working together in order to realize the organization's objectives; it helps managers to comprehend that decisions and actions that are taken in one organizational area will eventually affect others, and this helps them to understand that organizations are not self-contained, but instead rely on their environment for vital inputs and as outlets to absorb their outputs (Robbins et al., 2012).

The contingency approach states that organizations are diverse; they face dissimilar situations and need different methods of managing. It aids us to understand management, since it emphasizes that there are no basic or universal rules for managers to follow. Instead, managers have to look at their situation and decide the best way to manage according to the situation that they are in (Robbins et al., 2012).

3 Defining the objectives of the dissertation based on the analysis of the current state

3.1 Objectives

The main objective of the research is to examine the level of organizational culture in organizations to seek appropriate managerial approaches and methods for the development of organizational culture in a manner that could support the environment for innovation in the organization, in order to facilitate entrepreneurship in the Industry 4.0 concept. The sub-objectives of this research are as follows:

O1: To explore and present the concept of Industry 4.0 in relationship with the use of suitable managerial approaches for the development of an organizational culture that is supporting to the process of innovation in organizations.

O2: To analyze the level of organizational culture in organizations based on the organizational culture index.

O3: To argue and formulate recommendations in order to reinforce organizational culture that is supporting Industry 4.0 based on the findings.

To achieve the aforementioned objectives, the following steps were to be taken:

- To analyze the existing state of implementing industry 4.0 – research of literature as well as business case studies.
- To identify benchmarks and factors within individual pillars of implementing industry 4.0 – search of foreign specialized literature and description based on a questionnaire survey.
- To identify the level of organizational culture in organizations in the Czech Republic – search of foreign specialized literature and description based on a questionnaire survey.
- To answer the identified research question, based on primary research.

Three research questions have been formulated in connection with the objectives of the research, which examines organizational culture in the context of the 4th Industrial Revolution:

RQ1: Does organizational culture in organizations support the introduction of the Industry 4.0 concept?

RQ2: Which determinants of organizational culture motivate an organization to implement Industry 4.0?

RQ3: What is the difference in organizational culture according to the organizational culture index in 2013, 2015 and 2017?

3.2 Hypotheses

Hypothesis $H_0$1 and $H_0$2 were defined according to the research questions:

$H_0$1: The innovative organizational culture according to the index of organizational culture depends on the size of an organization in question.

$H_0$2: The innovative organizational culture according to the index of organizational culture depends on the type of an organization in question (domestic, international, transnational, state/state-funded).

3.3 Research methods

Both qualitative and quantitative methods are used to diagnose organizational culture. Each of these methods has its advantages and disadvantages, which is why a combination of both these methods is often used in practice.

There are several methods for measuring the levels of organizational culture; the following appear to be the most commonly used quantitative techniques:

- The Organizational Culture Assessment Instrument (OCAI) – the questions in the questionnaire focus on 6 content-based components that are intended to describe the basic manifestations of an organizational culture.
- The Organizational Culture Profile (OCP) – 54 values are determined within 7 basic dimensions, namely innovation, stability, people orientation, outcome orientation, easygoing, detail orientation, and team orientation.
- The Organizational Culture Inventory (OCI) – comprises a total of 120 statements which the respondent evaluates using a five-point scale, where 1 means zero identification with the statement and, in contrast, 5 means complete identification.

OCI examines organizational culture at the level of behavioral norms (12 sets of norms are grouped into three groups).

- The Organizational Ideology Questionnaire (OIQ) – developed by R. Harrison, QIQ builds on organizational culture typology: culture oriented to power, roles, tasks, and individuals. This is a typological questionnaire containing statements, where the respondent selects those statements that best represent their organization.
- The Organizational Culture Index (OCI) – Wallach (1983) describes organizational cultures in three dimensions: bureaucratic, innovative and supportive. The questionnaire comprises 24 items that characterize the organization (eight items for each dimension). It is evaluated using a four point Likert scale with responses ranging from 0 (does not describe our organization) to 3 (describes our organization in most cases).

Each of the tools allows a different view of the organization: while some aspects and areas of organizational culture are revealed, others remain hidden. When deciding on the choice of the most appropriate tool for organizational culture research, the authors recommend asking two basic questions: what is the purpose of the diagnosis and what will be the information obtained by the research? On the basis of the answers, the researcher can choose among the tools whose basic descriptions are presented by the authors, and thus capture the best-defined goal of organizational culture research.

The most appropriate method that was chosen for the purpose of this research is a questionnaire survey, and particularly the Wallach's Questionnaire (1983) - Organizational Culture Index (OCI) in Czech language. Ellen J. Wallach has classified organizational culture into three dimensions: bureaucratic, supportive, and innovative; where bureaucratic culture is considered to be a prominent hierarchical organization that is highly organized with a clear line of authority defined. The supportive culture however focuses on interpersonal relationships and it is based on mutual trust, encouragement and co-operation. Innovative culture is considered to be dynamic and it supports creative work, carries new challenges and encourages risky behavior (Wallach, 1983).

To analyze organizational culture, the same study was conducted in organizations in the Czech Republic repeatedly in two-year cycles, i.e. 2013, 2015 and 2017.

Wallach's actual questionnaire consisted of four sections.

The first section included three demographic questions: the gender, age and education level of the respondent. The second section included five questions relating to the characteristics of the organization in which the respondent works: ownership of the organization (Czech ownership, foreign ownership, international corporations, and public/governmental organizations), size of the organization (up to 50 employees, up to 250 employees, up to 500 employees, and over 500 employees), and the position of the respondent (a manager – with supervisory responsibility for employees, an employee without supervisory responsibility for employees), and the area of business activity.

The third section contains the Czech translation of Wallach's questionnaire (1983) – the Organizational Culture Index (OCI). OCI describes organizational cultures in three dimensions: bureaucratic, innovative and supportive.

The questionnaire comprises 24 items describing the organization. It is evaluated using a four point Likert scale with responses ranging from 0 (does not describe our organization) to 3 (describes our organization in most cases). The responses were then evaluated for each dimension of organizational culture (eight items for each dimension).

The fourth section addressed the Czech version of the "Job Satisfaction Questionnaire" (Spector, 1985), which comprises 36 items and was used to measure the perceived level of job satisfaction – the results are not part of this paper (Franěk, 2014; Sokolová; 2016).

Operationalization of variables

The organization's innovation culture variable will be expressed using the Organization's Innovation Index, which can acquire values based on the four point Likert's scale item rating standardized by the Wallach's Questionnaire (1983). The variable size of the organization will be judged based on the number of employees and divided into four categories (1; 2; 3; 4). The variable type of organization will be judged according to the organization's nature and the organization will be divided into four categories (domestic, international, transnational, state / funded).

In order to test the H1 hypothesis (The innovative organizational culture according to the index of organizational culture depends on the size of an organization in question), based on the nature of the data, calculations will be based on Spearman's correlation coefficient. Alternatively, because both variables have a small number of categories, the Kendall

coefficient or the Goodmann-Kruskalov gamma coefficient could be also taken into account. Usually, the Spearman coefficient and the Kendall coefficient are similar, if that were not the case; a lower value coefficient will be selected. The gamma factor is usually higher than the above-mentioned coefficients.

To test the H2 hypothesis (The innovative organizational culture according to the index of organizational culture depends on the type of an organization in question (domestic, international, transnational, state/state-funded)), with respect to the nominal level of measurement (organization type), the chi-quadrate will be used. We may also consider Cramer's V (Mareš, Rabušic, Soukup, 2015).

To determine the organization's dependence and the culture innovation index - H1 (which will be in the range 24-96), we will rely on the nature of the data.

If the normal distribution requirements are fulfilled for each data group, Shapiro-Wilkow (1965) and eventually D'Agostin test (1971) will be used for testing, which extends Shapir-Wilk's test for medium and large selections and data homogeneity (Fisher-Snedecor F-test).

If the data normality is rejected and the data homogeneity condition is met, variance analysis (ANOVA) may be used.

At the end after testing and examining the data the following methods were used to make the statistical analyses. The breakdown of the score in all of the three culture dimensions is approximately symmetric, and quite close to normal (although tests did not confirm this), without significant anomalies. Differential single factor analysis was used to verify differences between groups. Where the dispersion homogeneity was not confirmed, a Brown-Forsythe test was used as an alternative. Different post-hoc tests were used to learn differences between groups (Bonferroni or Dunnett). As an alternative, the nonparametric analogy of the Anova-Kruskal-Wallis test was added. All calculations were performed in SPSS Statistics v. 24.0.

A short description of the statistical tests that were used to test the hypothesis:

Mann-Whitney U-Test

The Mann–Whitney U-test is among of the most frequently used nonparametric tests to compare samples from two populations in those cases when the subsequent assumptions are fulfilled:

1. The two samples are independent and random.

2. The value measured is a continuous variable.

3. The measurement scale used is at least ordinal.

4. If they differ, the distributions of the two populations will differ only with respect to central location (Groebner et al., 2008).

ANOVA

Analysis of variance (ANOVA) can be used to test whether there are differences between three or more population means. There are some different types of ANOVA procedures, depending on the type of test being conducted.

ANOVA is an analysis of variance design wherein independent samples are attained from two or more levels of a single factor in order to test whether the levels have equal means (Groebner et al., 2008).

ANOVA tests the null hypothesis that three or more populations have the same mean. The test is based on four assumptions:

1. All populations are normally distributed.

2. The population variances are equal.

3. The observations are independent—that is, the occurrence of any one individual value does not affect the probability that any other observation will occur.

4. The data are interval or ratio level (Groebner et al., 2008).

Kruskal-Wallis

Kruskal–Wallis One-Way Analysis of Variance is the nonparametric counterpart to the one-way ANOVA procedure. It is applicable any time the variables in question satisfy the following conditions:

1. They have a continuous distribution.

2. The data are at least ordinal.

3. The samples are independent.

4. The samples come from populations whose only possible difference is that at least one may have a different central location than the others (Groebner et al., 2008).

Brown-Forsythe

The Brown and Forsythe Test is a test for equal population variances. It is a vigorous test based on the absolute differences within each group from the group median. It is a suitable alternative to Bartlett's Test for equal variances, which is sensitive to lack of normality and unequal sample sizes (Brown & Forsythe, 1974a).

The test does not assume that all populations are normally distributed and is recommended when the normality assumption is not viable (Brown & Forsythe, 1974a).

Cronbach's alpha

"*Internal consistency reliability is concerned with whether or not scales of the test include questions that are measuring a coherent trait or ability*" (Cripps, 2017). This level of coherent is statistically measured by Cronbach's alpha introduced by Cronbach in 1951 where a random relationship among questions (items) would have an alpha coefficient of 0, and those questions, which are identical, would have a coefficient of 1.

A common rule of thumb for interpreting Cronbach's alpha is as described in table 6:

Table 6: Interpretation of Cronbach's alpha

Internal consistency	Cronbach's alpha
Excellent	$\alpha \geq 0.9$
Good	$0.9 > \alpha \geq 0.8$
Acceptable	$0.8 > \alpha \geq 0.7$
Questionable	$0.7 > \alpha \geq 0.6$
Poor	$0.6 > \alpha \geq 0.5$
Unacceptable	$0.5 > \alpha$

Source: (Cripps, 2017)

4 Results

4.1 Demographic results

The following tables are the results of the demographic part of the questionnaire, which contained the gender, age, education, size of the organization they work for, type of ownership, their position in the organization, and the years that they have been working at the organization:

Table 7: Gender of the respondents

	2013		2015		2017	
	%	N	%	N	%	N
Male	42.40	753	42.11	619	45.73	675
Female	57.60	1023	57.89	851	54.27	801

Source: Author

From the table above, it is clear that in the survey years, the number of female participants was slightly over the number of male participants. In the last year of 2017, the number of male participants increased but did not exceed the number of female participants.

Table 8: Age of the respondents

	2013		2015		2017	
	%	N	%	N	%	N
To 20	2.48	44	2.11	31	3.25	48
21 - 30	35.42	629	34.22	503	35.23	520
31 - 40	30.18	536	30.68	451	26.29	388
41 - 50	20.10	357	21.22	312	21.41	316
51 - 60	9.97	177	10.54	155	11.79	174
61 and more	1.86	33	1.22	18	2.03	30

Source: Author

The strongest age categories are 21-30 years and 31-40 years in all years of investigation. There were much less respondents in the first and final age categories, but the results are still interpretable in this respect.

Table 9: Education of the respondents

	2013		2015		2017	
	%	N	%	N	%	N
Elementary educational level	1.24	22	0.75	11	0.34	5
Skilled worker	9.68	172	6.39	94	8.27	122
Secondary school	42.45	754	48.78	717	45.05	665
Higher professional school	6.36	113	6.53	96	5.69	84
University degree education	32.09	570	28.71	422	31.23	461
Undergraduate (distance) learning	8.16	145	8.84	130	9.42	139

Source: Author

The most frequent representation of the respondents' education is the Secondary school. On the contrary, the group with Elementary educational level is the least represented. This distribution does not correspond to the occurrence in the whole population of the Czech Republic.

Table 10: Organization size

	2013		2015		2017	
	%	N	%	N	%	N
Up to 50 employees	36.09	641	33.33	490	34.62	511
Up to 250 employees	29.90	531	27.89	410	26.02	384
Up to 500 employees	9.07	161	8.16	120	10.98	162
Over 500 employees	24.94	443	30.61	450	28.39	419

Source: Author

The most respondents were the respondents from small firms to 50 employees and large companies with over 500 employees. The division of the size of the organization is according to the Czech Statistical Office, where it is not necessary to consider the turnover of the company compared to the division according to the EU Directive.

Table 11: Ownership of the organization

	2013		2015		2017	
	%	N	%	N	%	N
Czech owner	42.29	751	44.49	654	42.82	632
International	34.46	612	35.78	526	36.52	539
Public/governmental organization	23.25	413	19.73	290	20.66	305

Source: Author

Approximately 35% of the participants work for International organizations, and this is a large percentage compared with the participants who work for companies with Czech owners (42.29 - 44.49%).

Table 12: Position of the respondents in the organization

	2013		2015		2017	
	%	N	%	N	%	N
Non-supervisory responsibility employee	75.56	1342	70.82	1041	71.88	1061
Manager/supervisory responsibility employee	24.44	434	29.18	429	28.12	415

Source: Author

Most of the people who participated in the survey are employees. The share of managers among respondents was less than 30%.

Table 13: Years of work experience in current company

	2013		2015		2017	
	%	N	%	N	%	N
To 1	14.58	259	15.92	234	17.28	255
To 10	59.07	1049	56.19	826	58.81	868
To 20	18.30	325	20.20	297	15.51	229
To 30	6.25	111	5.85	86	6.98	103
31 and more	1.80	32	1.84	27	1.42	21

Source: Author

The length of work experience in current company ranged from 60% to 1 to 10 years. Practice under 1 year was 14.58% (2013) to 17.28% (2017).

4.2 Organizational Culture Index

Cronbach's alpha was calculated for the 24 individual questions of the Wallach's questionnaire to check the internal consistency based on the dimensions they were associated with in order to verify the validity and reliability of the questionnaire.

Basically questions 3, 4, 10, 12, 14, 20, 21, and 24 are mostly associated with the bureaucratic culture; questions 1, 6, 7, 11, 13, 18, 19, and 23 are mostly associated with the innovative culture; and questions 2, 5, 8, 9, 15, 16, 17, and 22 are considered to be mostly associated with the supportive culture. The results of Cronbach's alpha are shown below in table 14.

Table 14: Cronbach's alpha reliability analysis

	2013	**2015**	**2017**	**Total**
Bureaucratic	0.717	0.713	0.700	0.710
Innovative	0.705	0.688	0.705	0.699
Supportive	0.823	0.810	0.782	0.808

Source: Author

From the results of the Cronbach's alpha it is evident that the bureaucratic culture's internal consistency is considered to be acceptable ($.8 > \alpha \geq .7$) according to Cripps (2017).

The supportive culture's internal consistency is considered to be Good ($.9 > \alpha \geq .8$) in the years 2013 and 2015, and acceptable in the 2017.

For the internal consistency of the innovative culture the results are acceptable for the years 2013 and 2017 however in the year 2015 Cronbach's alpha is 0.688; and it is considered to be questionable ($.7 > \alpha \geq .6$).

Nevertheless, since it is only slightly less than 0.7 and the total internal consistency of innovative culture are 0.699, we can consider it as acceptable as well.

Means of the individual dimensions calculated and also The Mann-Whitney U-test was carried out in order to test the null hypothesis of the research; the mean values and the results of the U- test are shown in the following tables:

Table 15: Means according to the size of organization

	2013			2015			2017			total		
	bure.	innov.	supp.	bure.	innov.	supp.	bure.	innov.	supp.	bure.	innov.	supp.
0-50	14.02	12.38	15.91	13.61	11.91	15.50	14.03	11.60	15.40	13.90	12.00	15.63
51-250	15.31	11.70	14.27	15.21	11.89	13.60	15.28	11.86	14.14	15.27	11.80	14.02
251-500	16.22	11.65	13.93	15.93	11.59	13.46	15.79	11.33	13.66	15.98	11.52	13.70
501+	17.59	11.77	13.83	17.28	11.96	13.82	16.84	12.17	14.35	17.25	11.96	13.99
Total	15.50	11.96	14.72	15.37	11.89	14.29	15.35	11.80	14.58	15.41	11.89	14.54

Source: Author

In the table 15 all the mean values of bureaucratic, innovative and supportive dimensions are presented according to the size of organization.

Table 16: U-test according to the size of organization

	2013 - 2015			2013 - 2017			2015 - 2017		
	bure.	innov.	supp.	bure.	innov.	supp.	bure.	innov.	supp.
0-50	0.068	0.120	0.105	0.859	0.006	0.023	0.103	0.268	0.640
51-250	0.588	0.553	0.022	0.913	0.729	0.654	0.670	0.854	0.071
251-500	0.516	0.957	0.581	0.250	0.427	0.710	0.692	0.442	0.816
501+	0.371	0.519	0.896	0.002	0.215	0.049	0.032	0.559	0.066

Source: Author

In the table above (Table 16) we have the results of the U- test according to the size of the organization in the years 2013, 2015, and 2017 for the four size groups that were presented in the questionnaire.

In the table 17 all the mean values of bureaucratic, innovative and supportive dimensions are presented according to the type of organization.

Table 17: Means according to the type of organization

	2013			2015			2017			total		
	bure.	innov.	supp.	bure.	innov.	supp.	bure.	innov.	supp.	bure.	innov.	supp.
CZ	14.37	12.07	14.62	13.90	12.37	14.65	14.37	11.95	14.75	14.22	12.13	14.67
INTER	16.68	12.98	14.83	16.37	12.49	14.34	16.12	12.62	14.56	16.41	12.71	14.59
STATE	15.79	10.23	14.75	16.86	9.73	13.39	16.01	10.03	14.29	16.16	10.03	14.22
Total	15.50	11.96	14.72	15.37	11.89	14.29	15.35	11.80	14.58	15.41	11.89	14.54

Source: Author

The following table (table 18) we have the results of the U- test according to the type of the organization in the years 2013, 2015, and 2017 for the type groups that were presented in the questionnaire; however, since there were no significant differences between international and transnational organizations, the two groups were merged as a single group under the title "International". Therefore, all the calculations and analyses that are made according to the type of the organization are made for 3 groups: Czech (CZ), International (INTER), and State (STATE).

Table 18: Mann-Whitney U-test results according to the type of organization

	2013-2015			2013-2017			2015-2017		
	bure.	innov.	supp.	bure.	innov.	supp.	bure.	innov.	supp.
CZ	0.049	0.073	0.951	0.890	0.607	0.723	0.036	0.029	0.766
STATE	0.000	0.073	0.000	0.600	0.531	0.169	0.006	0.260	0.005
INTER	0.109	0.031	0.096	0.004	0.084	0.358	0.240	0.655	0.455

Source: Author

The following 6 figures bellow illustrate the graphical representation of the Means that are in the tables 15 and 17 according to individual dimensions for size and type of organizations.

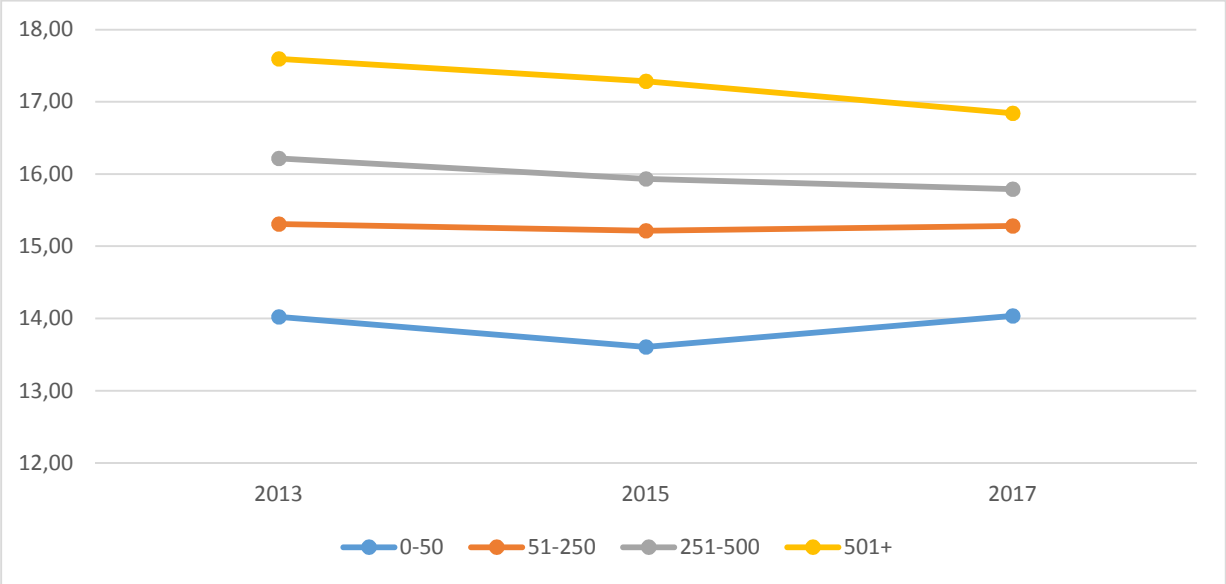

Figure 13: Mean values of the bureaucratic dimension according to the size of organizations

Source: Author

Figure 13 basically shows the average value of the bureaucratic index for the different organization size groups. At the first glance it is evident that the larger the size group is, the larger the value gets; meaning that the larger organizations have more tendency to have a bureaucratic organizational culture than the smaller ones. This makes sense because larger organizations relay more on rules and regulations and need some law and order to be able to manage large groups of people.

One other thing that we can notice in figure 13 is that the average value of the bureaucratic index has been slightly decreasing for the larger organization size groups (251-500 & 501+) but it has remained almost the same for the other two groups.

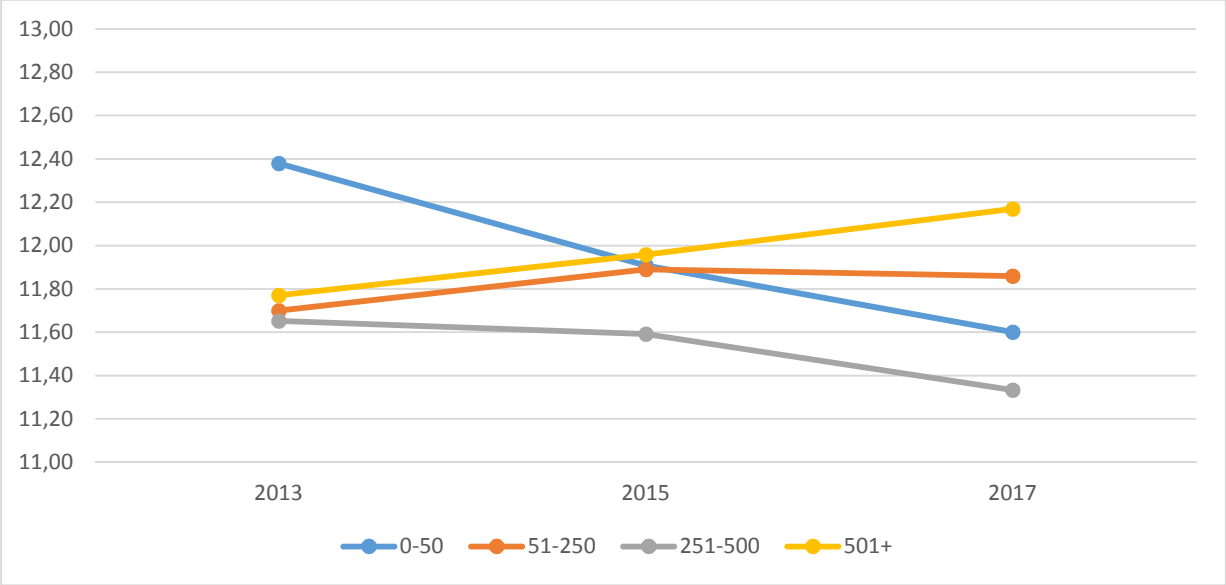

Figure 14: Mean values of the innovative dimension according to the size of organizations

Source: Author

In figure 14 the average value of the innovative index is shown for the different organization size groups. The average value of the innovative index of the smallest group (0-50) has been consistently decreasing from 2013 to 2017. The same could be said about the size group 251-500, but with a lower intensity.

On the other hand, the other two groups the average value of the innovative index has been increasing meaning that these groups are leaning towards having a more innovative culture. The size group 500+ has the highest score in 2017; this could be due to the fact that the large organizations have bigger budgets to spend on innovation and innovative projects.

The next figure (15) shows the average value of the supportive index for the different organization size groups. The smallest size group (0-50) has the highest score meaning that their organization culture is closer to supportive culture than the other groups, however through the years 2013 to 2017 this value has been decreasing. For the other groups it looks like their average started to increase from 2015 to 2017 but it was decreasing prior to that in two of the groups.

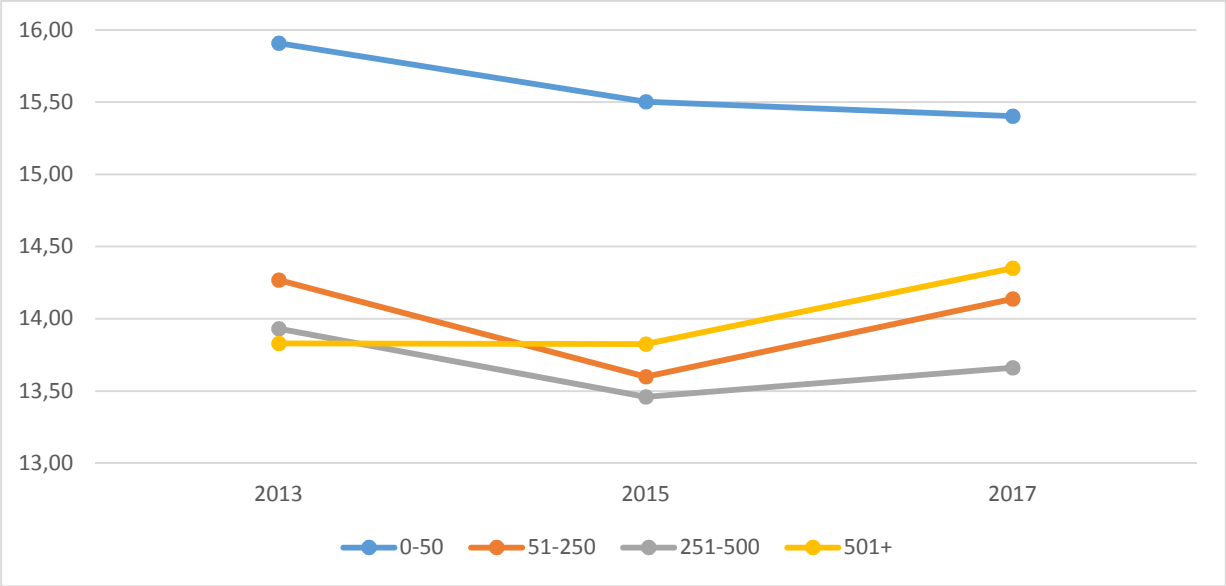

Figure 15: Mean values of the supportive dimension according to the size of organizations

Source: Author

The following three figures bellow (16, 17, and 18) illustrate the graphical representation of the U-test results that are in the table 17 according to individual indexes for the type of organizations.

In the figure below (figure 16) the first thing that is evident is that the organizations with Czech ownership have a lower bureaucratic culture than the other types of organizations. This makes sense because the organizations owned by the state mostly have some set of rules and checklists an specifics way of doing things in order to maintain some level of control on everything from day to day operations to the more important tasks.

It is very similar in the case of international organizations since the organizations are operating in more countries and the owners/shareholders need to be able to monitor and control their interests' offshores.

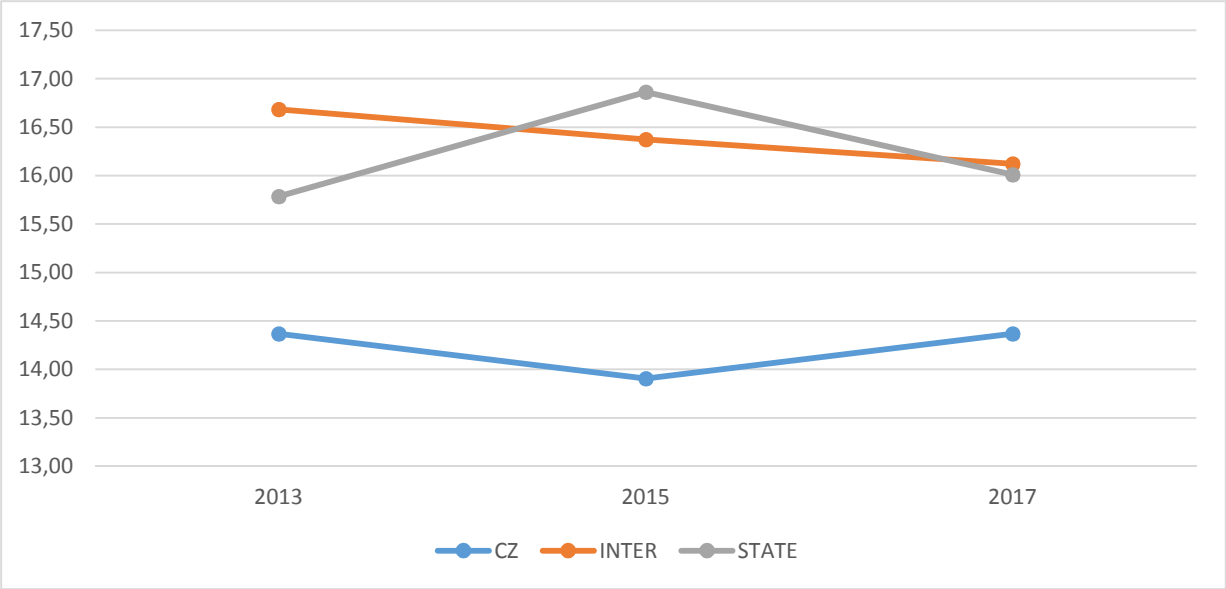

Figure 16: Mean values of the bureaucratic dimension according to the type of organizations

Source: Author

Figure 17 illustrates the mean values of the innovative culture according to the type of organizations. It is clearly visible that the organizations owned by the Czech state the score of the innovative culture is the less that the other two types in all the years. Organizations with Czech owners and international organizations have a similar but opposite trends.

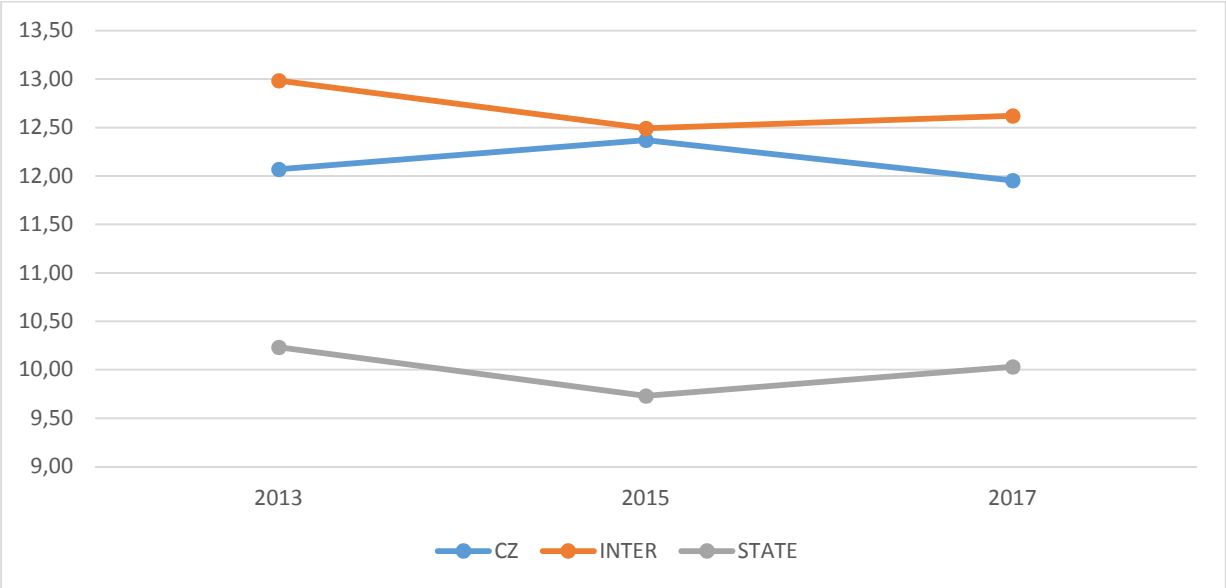

Figure 17: Mean values of the innovative dimension according to the type of organizations

Source: Author

Mean values of the supportive dimension according to the type of organizations are presented in fig 19. Czech companies have maintained a slightly increasing trend line from 2013 to 2017, but the same cannot be said for the other two groups the both had a drop in 2015. State owned organization had a bigger drop than the international organizations. This could hold different meanings and could be explained in different ways.

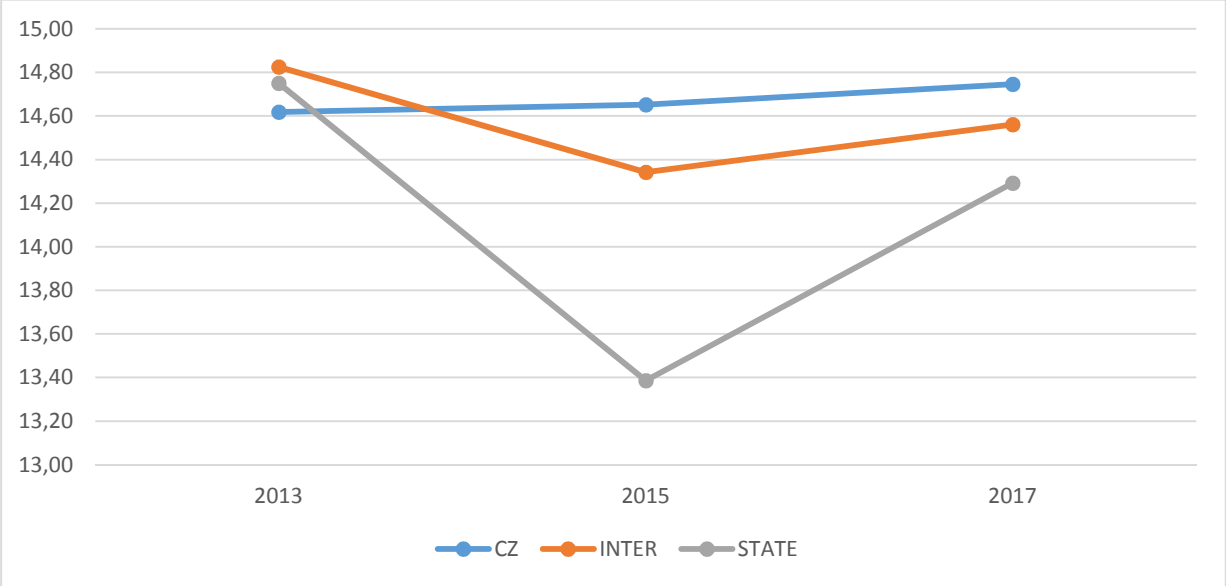

Figure 18: Mean values of the supportive dimension according to the type of organizations

Source: Author

Throughout most the figures it seems that there is a sudden jump in the year 2015, which begs the question: if some irregularities were present in the data or the Mann-Whitney U-test is not suitable. On the other hand, these sudden changes could be due to some socio-economic or political events prior to the year 2015. This could be discussed more later on but first of all, data should be checked and other statistical analyses are to be done to confirm the results.

With the first look at the questions, one wonders if the respondents always understood the terms. There are concepts like explosive and overpressure, which one probably do not know how to grasp and perhaps they risk being a regular worker hoping that they do not work in such a company and do not have to look for a new job. Do the employees really know what the company is like?

Table 19: Frequency of responses in relation to culture

	Bureaucratic	Innovative	Supportive
0	0.0%	1.0%	1.0%
1	0.0%	1.8%	0.3%
2	0.2%	0.6%	0.4%
3	0.1%	1.7%	0.4%
4	0.2%	2.6%	1.3%
5	0.7%	4.5%	1.7%
6	0.9%	4.4%	2.2%
7	1.9%	5.5%	3.1%
8	2.7%	8.0%	3.9%
9	4.6%	8.9%	5.9%
10	5.2%	8.8%	7.1%
11	7.0%	9.4%	7.7%
12	8.7%	10.2%	8.1%
13	9.1%	9.5%	6.7%
14	9.3%	7.2%	8.4%
15	8.7%	5.6%	8.4%
16	7.4%	4.7%	6.8%
17	8.0%	3.1%	6.5%
18	7.8%	1.5%	6.0%
19	5.8%	1.1%	4.3%
20	5.3%	0.3%	4.1%
21	3.9%	0.1%	2.8%
22	1.6%	0.0%	2.2%
23	0.9%	0.0%	1.4%
24	0.0%	0.0%	0.0%

Source: Author

Figure 19 is the created from the data in table 19. It is visible that the distribution of the data more or less similar to normal distribution. The breakdown of the score in all of the three

culture dimensions is approximately symmetric, and quite close to normal (although tests did not confirm this), without significant anomalies.

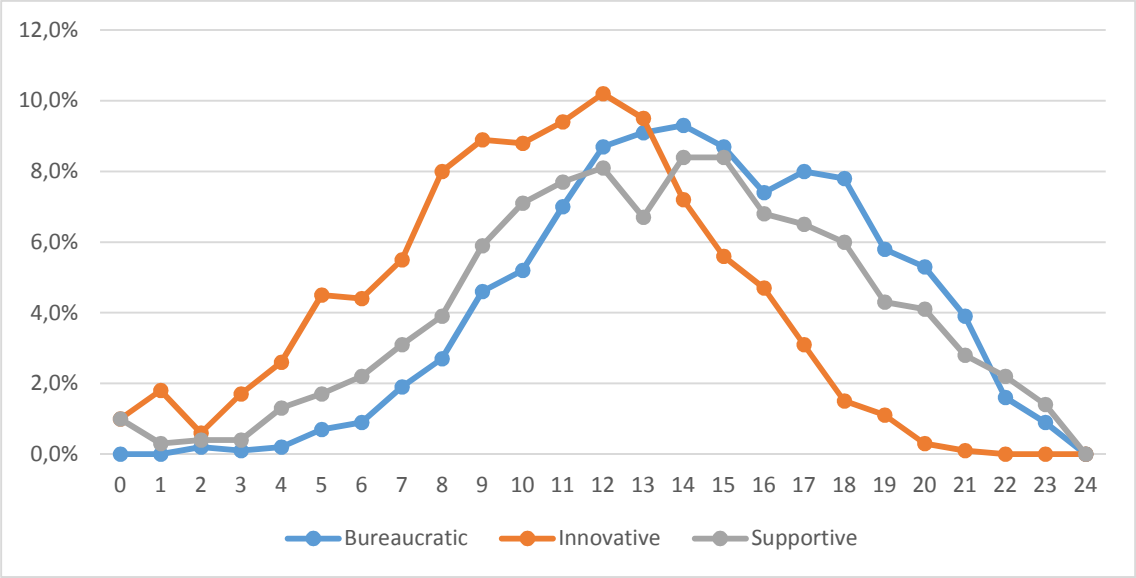

Figure 19: Frequency of responses in relation to culture

Source: Author

Differential single factor analysis was used to verify differences between groups. Where the dispersion homogeneity was not confirmed, a Brown-Forsythe test was used as an alternative. Different post-hoc tests were used to learn differences between groups (Bonferroni or Dunnett). As an alternative, the nonparametric analogy of the Anova-Kruskal-Wallis test was added.

4.3 Test of hypothesis

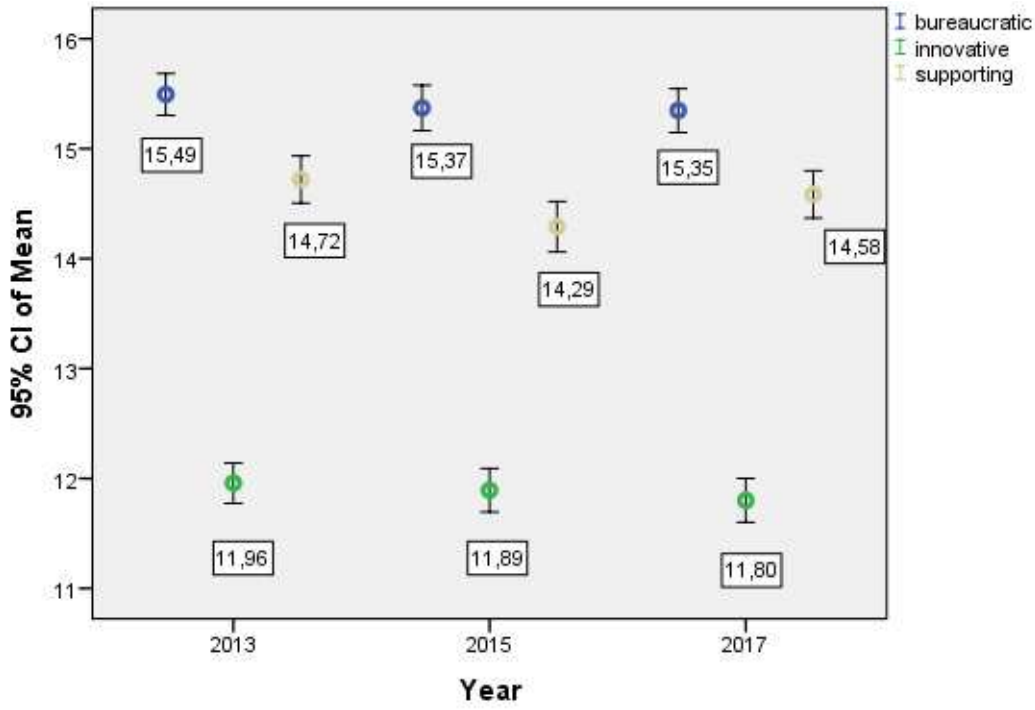

Figure 20: mean value of the culture indexes in years 2013, 2015, and 2017

Source: Author

The average rating is somewhere around 12 for the innovative culture, there is a need to answer whether it is little or not. Compared to indicators bureaucratic and supportive, it is less. How much should it be to make it satisfactory? How much the employer should have to be considered as sufficiently innovative (or even supportive)? It would mean at least some values for comparison as it is elsewhere. The following table was made according to the frequency of responses in relation to the culture in order to better understand the characteristics of data.

The mean values of the culture indexes are shown in the figure 20. It is clearly visible that the bureaucratic culture has repeatedly had the highest mean, closely followed by the supportive culture on the second place, and the innovative culture has the smallest mean value among others.

Table 20: Results of Statistical analyses of the culture indexes in years 2013, 2015, and 2017

	Bureaucratic	Innovative	Supportive
ANOVA	0.528	0.519	0.022*
Kruskal-Wallis	0.351	0.537	0.023
Differences			2013 vs. 2015

* Brown-Forsythe test used for non-homogeneity of scattering

Source: Author

The last row of table 20 shows values that are different; Tests do not show significant differences for bureaucratic and innovative cultures. However, in the case of supportive culture in 2013 to 2015, a statistically significant difference is demonstrated, and in our case, a decline in cultural value.

But even under this criterion development is not staggering. It suggests that the evaluation does not change fundamentally, according to conditional averages, it seems that the overall rating might have fallen somewhat over time.

Employee expectations have been growing in the recent years and this could have played a role in this case and it may have an impact on the evaluation.

4.3.1 Dependence on the size of the organization ($H_0$1)

In this part the test results of the null hypothesis of the dissertation are presented.

$H_0$1: The innovative organizational culture according to the index of organizational culture depends on the size of an organization in question.

Initially the size of organization was divided into four groups in in the questionnaire (up to 50, 50-250, 251-500, and 500+).

The tests were repeated twice according to size:

- First for the initial division into 4 groups (up to 50, 50-250, 251-500, and 500+).
- The second time according to 3 groups (50, 250, or more).

The reason behind this decision is that the 250-500 category is considerably smaller than the others and therefore it is more variable. Additionally, it is not very good for ANOVA, if there are big differences in the group sizes.

The results are presented in the following figures and tables.

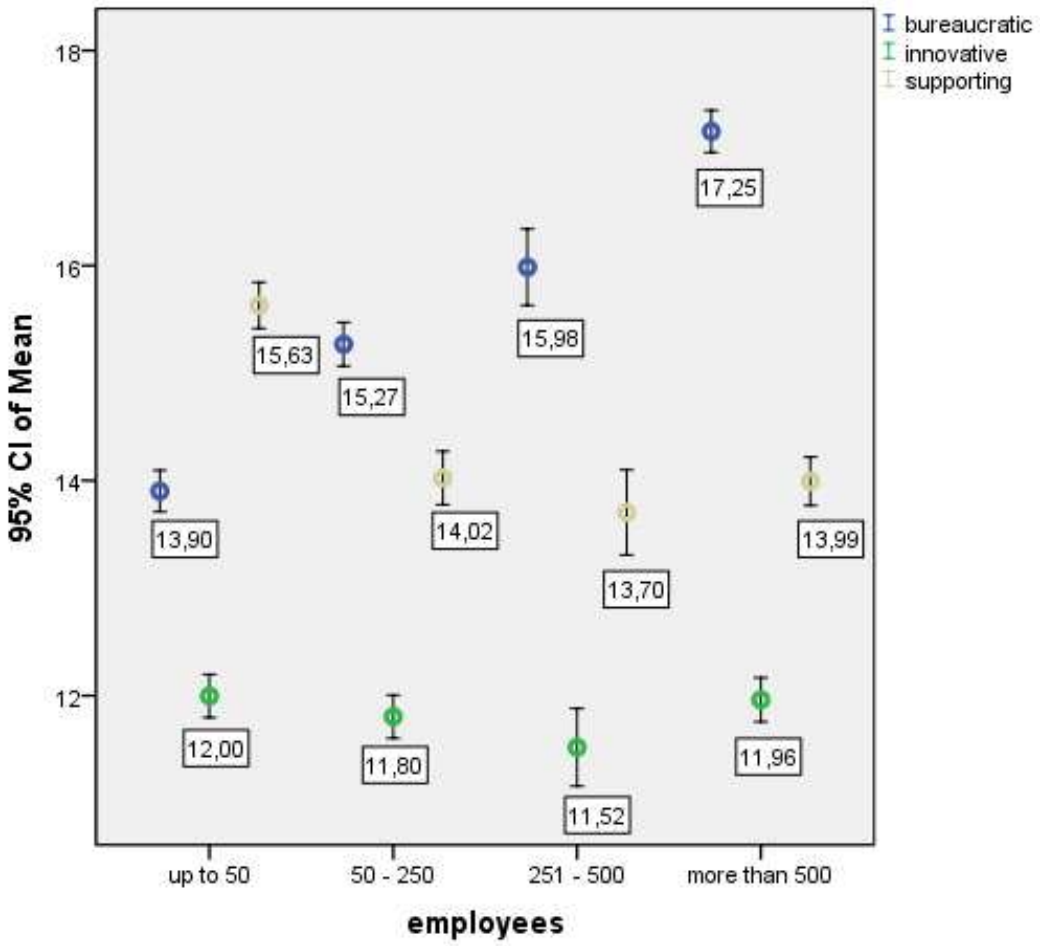

Figure 21: Dependence on the size of the organization (4 categories)

Source: Author

Here we can see that the bigger the size of the organization, bureaucratic culture consistently gets stronger. On the contrary it seems that the bigger the organization gets the less supportive culture it has. Innovative culture however looks similar.

Table 21: Results of Statistical analyses of dependence of the culture indexes on the size

	Bureaucratic	Innovative	Supporting
ANOVA	<0.001*	0.095*	<0.001*
Kruskal-Wallis	<0.001	0.137	<0.001
Differences	All		1-2,3,4

of company (4 categories)

* Brown-Forsythe test used for non-homogeneity of scattering

Source: Author

Test results in table 21 show what was mentioned before; we can see a statistically significant difference in bureaucratic culture between all group sizes and a statistically significant difference in supportive culture between the first group with all the other groups.

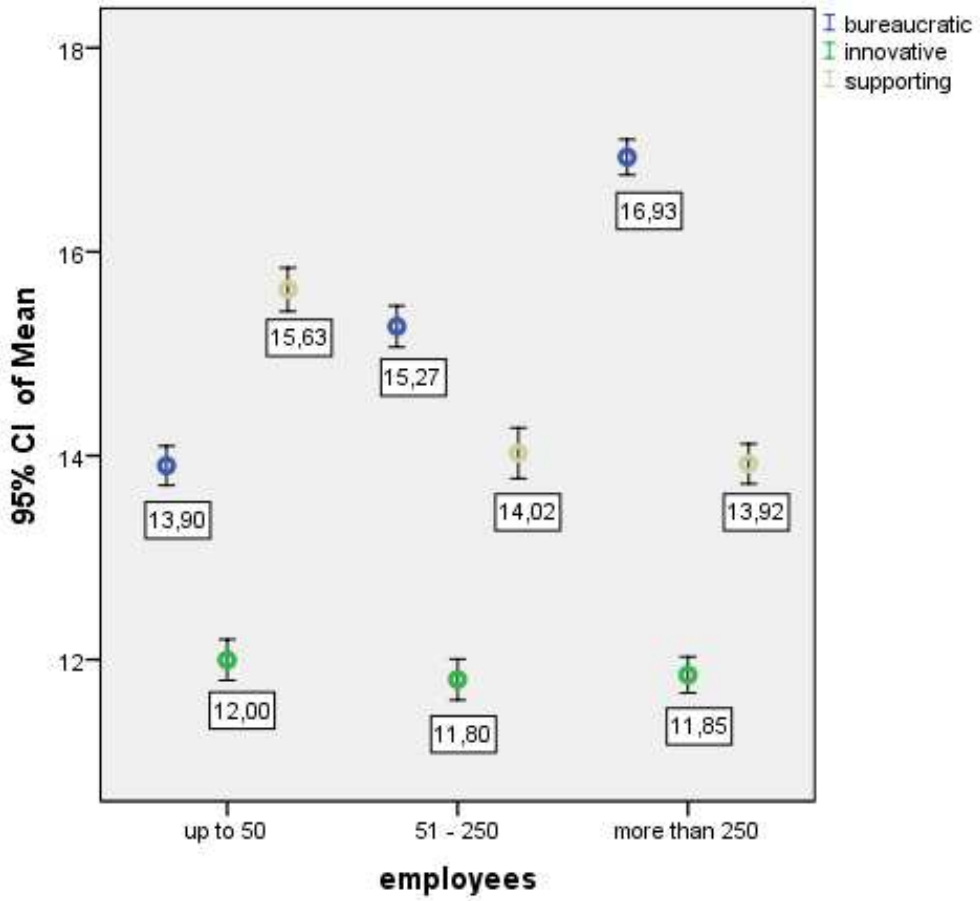

Figure 22: Dependence on the size of the organization (4 categories)

Source: Author

In figure 22 we can still see that the bigger the size of the organization, bureaucratic culture consistently gets stronger. On the other hand, the bigger the organization gets the less supportive culture it has. Innovative culture however looks similar. Comparing to figure 22 this table is more uniform unlike figure 22 where the innovative and supportive cultures were increasing for the 500+ group.

Table 22: Results of Statistical analyses of dependence of the culture indexes on the size of company (3 categories)

	Bureaucratic	**Innovative**	**Supporting**
ANOVA	<0.001*	0.358*	<0.001*
Kruskal-Wallis	<0.001	0.137	<0.001
Differences	1-2,1-3,2-3		1-2,1-3

* Brown-Forsythe test used for non-homogeneity of scattering

Source: Author

We can see that a statistically significant difference in bureaucratic culture in table 22 between first and second groups, first and third groups, and second and third groups. A statistically significant difference in supportive culture between the first with the other two groups is present.

In the assessment of an innovative culture, there is no significant difference between companies of different sizes; different large companies are comparable in this respect. On the other hand, small businesses have a significantly higher supportive culture than others.

4.3.2 Dependence on the type of organization ($H_0$2)

In this section the second null hypothesis is tested. There was one change made here as well: initially there were 4 groups according to the type of the organization in the questionnaire but due to the fact that there is not much of a difference between international and transnational organizations, the two groups were merged into one under the title “International”.

$H_0$2: The innovative organizational culture according to the index of organizational culture depends on the type of an organization in question (domestic, international, transnational, state/state-funded).

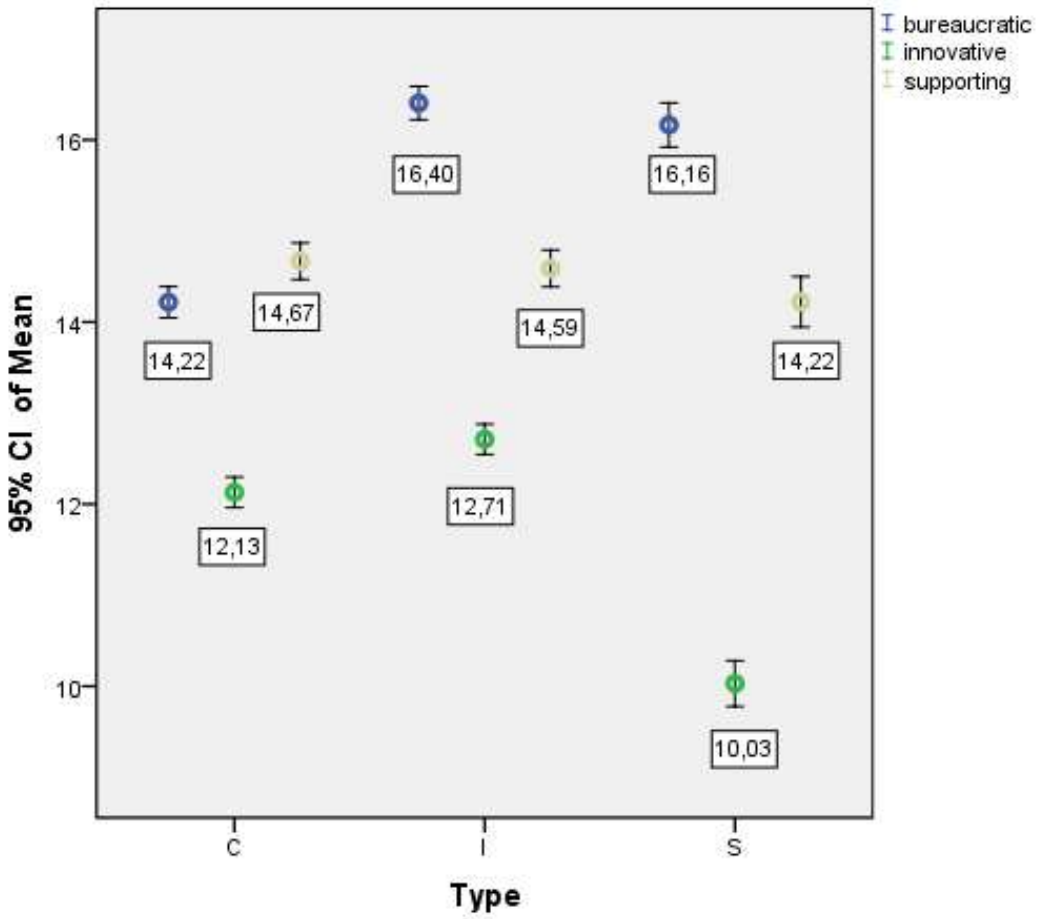

Figure 23: Dependence on the type of company (C- Czech, I-international, S-state organization)

Source: Author

From the figure above we can see that there are quite a few differences between the different types of organizations, we can see that the state organizations have the least innovative culture and the international organizations have the largest score in the bureaucratic culture.

Table 23: Results of Statistical analyses of dependence of the culture indexes on the type of company

	Bureaucratic	Innovative	Supporting
ANOVA	<0.001	<0.001*	0.029*
Kruskal-Wallis	<0.001	<0.001	0.003
Differences	C-I, C-S	C-I, C-S, I-S	C-S

* Brown-Forsythe test used for non-homogeneity of scattering.

Source: Author

In the overall assessment (for the whole period 2013-2017) there are obvious differences between different types of companies in all areas. The smallest differences are in the supportive culture, where there is a significant difference only between Czech companies and state organizations.

In the field of innovative culture, the evaluation is markedly the highest among international companies, behind them are Czech companies slightly lagging behind, and with great distance they are state organizations, which makes complete sense.

5 Discussion

The table 24 shows the number of companies in the European Union countries according to the size of them (how many employees they have). As it was mentioned in the results that the bigger the size of the organization, bureaucratic culture consistently gets stronger. Now let's see how many large organizations (more than 250) are in Czech Republic compared to EU.

Table 24 - Enterprises by business size (number of companies)

	1 to 9	10 to 19	20 to 49	50 to 249	More than 250
AUT	18 115	2 817	2 173	1 461	471
BEL	28 359	2 308	2 007	1 151	307
CZE	**163 076**	**4 483**	**3 932**	**3 069**	**865**
DNK	11 595	1 464	1 170	854	161
FIN	16 375	1 597	1 270	823	199
FRA	186 658	13 077	9 552	5 407	1 355
DEU	124 486	38 157	18 015	16 759	4 408
GRC	57 578	2 293	1 218	660	113
HUN	42 103	3 296	2 455	1 667	430
IRL	13 292	891	732	507	161
ITA	319 021	39 924	19 194	8 491	1 236
LUX	461	100	100	80	26
NLD	57 059	3 308	2 590	1 961	325
POL	172 907	7 789	7 394	6 340	1 637
PRT	54 635	5 650	4 222	2 176	270
SVK	64 394	1 453	1 227	1 056	283
ESP	137 721	13 626	10 383	4 452	802
SWE	47 549	2 662	2 042	1 263	279
GBR	105 706	12 971	9 430	6 060	1 229
BGR	23 674	2 946	2 687	1 740	276
HRV	16 020	1 581	1 097	623	154
CYP	4 433	310	149	67	7
EST	5 558	639	575	426	61
LVA	9 220	722	646	450	52
LTU	16 998	1 158	967	710	136
MLT	1 944	118	48	56	0
ROU	35 059	4 989	4 409	3 124	768
SVN	16 869	1 017	589	488	111

Source: Own elaboration based on OECD data 2017

It is clear (figure 24) that Czech Republic is among the leading countries of EU with more number of large organizations, which tend to have a more dominant bureaucratic culture. This could be considered as an explanation to why in the years 2013, 2015, and 2017 the bureaucratic culture has had the highest mean values comparing to the innovative and supportive cultures shown in figure 20.

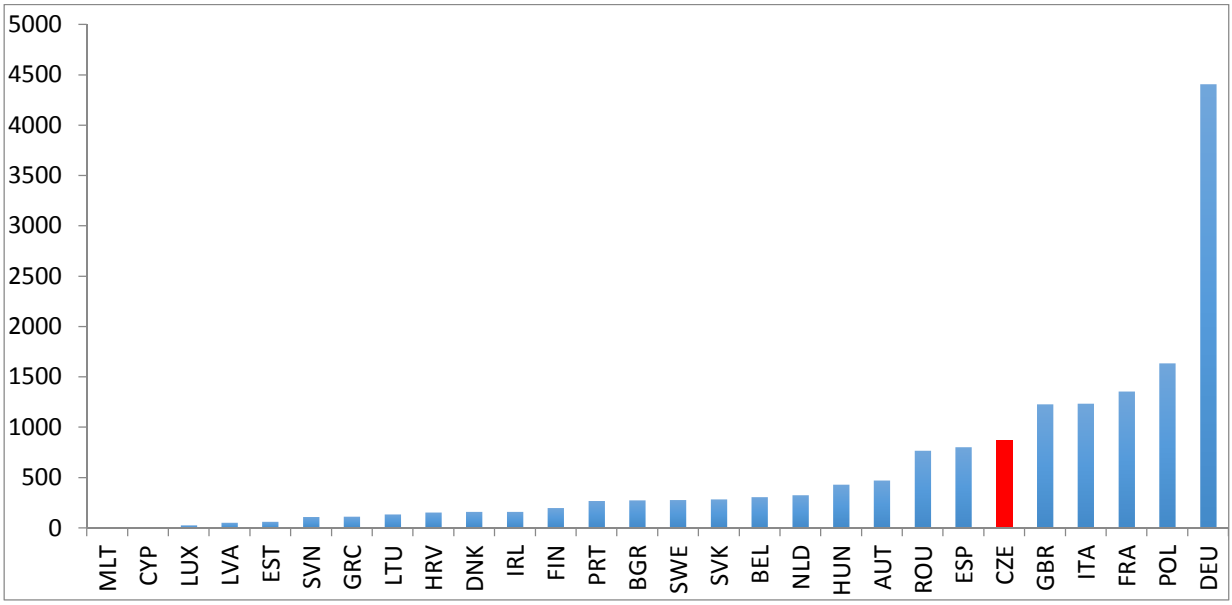

Figure 24: Enterprises by business size more than 250 persons employed in 2016

Source: Author's elaboration based on OECD data 2016

According to table 21 there is a statistically significant difference in bureaucratic culture between all group sizes and this makes sense because larger organizations relay more on rules and regulations and need some law and order to be able to manage large groups of people. According to Wallach (1983) bureaucratic culture is considered to be a prominent hierarchical organization that is highly organized with a clear line of authority defined.

A statistically significant difference in supportive culture between the first one compared with all the other groups, and as we can see in figures 21 and 22 the bigger the organization gets the less supportive its culture gets. This is also valid because the supportive culture however focuses on interpersonal relationships and it is based on mutual trust, encouragement and co-operation (Wallach 1983).

However, there is no significant difference in the innovative culture between the different size groups; this could probably be because mostly relay on being innovative but at the same time the bigger organizations are after innovative solutions rather than being innovative.

In the overall assessment (for the whole period 2013-2017) there are obvious differences between different types of companies in all areas. The smallest differences are in the supportive culture, where there is a significant difference only between Czech companies and state organizations.

In the field of innovative culture, the evaluation is markedly the highest among international companies, behind them are Czech companies slightly lagging behind, and with great distance they are state organizations, which makes complete sense.

The reason behind these differences could be explained by the 24 parameters of the Organizational Culture Index; the individual parameters are sorted in front of the type of culture they are mostly associated with:

- Bureaucratic culture: hierarchical, procedural, hierarchical structured, the Order rules here, activities are managed and regulated here, established/solid, careful, aimed at holding power.
- Innovative culture: risking, results-oriented, creative, overpressure/ explosive, stimulating, posing challenges, entrepreneurial, full of new ideas.
- Supportive culture: based on cooperation, relationship-oriented, supporting, friendly, allowing for personal freedom, fair, safe, trusting their employees.

Now, why the state owned organizations are less innovative? Because usually such organizations have a hierarchical structured with carefully managed rules and procedures so people who have power in such organizations prefer to stay in power so they do not promote creative work, they don't allow anyone to pose challenges and so on.

Similarly we could argue why the supportive culture gets weaker the larger the organization gets; supportive culture is based on cooperation and it is relationship-oriented with higher levels of trust, clearly in an environment where there are more people that employees have to work with it is more challenging to establish such values with others.

Nevertheless, "*Knowledge management cannot exist without knowledge engineering, and knowledge engineering cannot exist without people*" (Markopoulos & Kornilakis, 2016), and it is up to these very people to decide and promote such an organizational culture, which

supports creative work, carries new challenges and encourages risky behavior for better prosperity. The knowledge management literature continually stresses out the indivisible relationship between organizational culture and knowledge management (Rahman et al., 2018), and that a key factor for implementation of industry 4.0.

Use of results / benefits of outputs for science and practice and the perspective of further research

The benefits of the outputs of this research are assessed with regard to the question whether they contribute rather to the theoretical development of the information and knowledge management as a discipline or whether they help to solve rather practical problems in organizations. The two areas are specified below. In the last part further research and possibilities of elaboration and deployment of the given issue are presented and discussed.

Research outputs applicable in theory

First, this research of organizational culture - as a social dimension of the environment for specific innovations - brings a new insight into the topic of the Industry 4.0. In this regard it means an extension of the discipline of knowledge management and related fields (the outputs for the theory and science). The outputs therefore contribute to increasing of companies' readiness to introduce and deploy the Industry 4.0 concepts in new ways.

The outputs are to be used as an added value in the field of Information and Knowledge Management in several ways where this dissertation clearly shows the interconnection between the individual areas of the field while the organizational culture and its variety and levels is seen as an overarching link.

Last but not least, the dissertation contributes to the university courses, which deal with the knowledge management and company competitiveness. These are mainly courses at the Department of Information Technologies and the Department of Management of the University of Hradec Králové.

Nevertheless, the conceptualization of organizational culture presented in this dissertation can be introduced and used in the respective courses of other faculties. Namely, another related

area is also the studied program System Engineering and Informatics (since the research results associated with the Industry 4.0 concept may be categorized as engineering activities in soft systems).

In addition, as informational, communication and knowledge systems play an irreplaceable role in organizational culture, the use of the results can be specifically discussed from the standpoints of those areas.

Research outputs applicable in practice

The results can be applied for the needs of different organizations considering also various legal forms of these organizations. Explicitly, local, national or transnational contexts of those organization and their specifics should be regarded.

Further, the research outputs are addressed from several points of view. Particularly, the perspective of partial subjects defines how they are applicable or usable. This includes, for example, an individual's perspective, an organizational perspective, or a national or transnational perspective.

The partial subjective perception of the relevance of the research outputs for individual groups may of course overlap and intersect with the perception of others. In addition, the outputs are considered when appropriate as usable in the public or private sector.

The perspective of an individual

From an individual's point of view, it can be used to increase employees' satisfaction. Also, the company's prestige is supported by an index of supporting and innovative organizational culture from the point of view of the existing employees, resulting in the satisfaction of the employees with their job position, or the fact that they work for a company whose prestige is upgraded in this way.

It is a well-known fact that company managements have a supportive and innovative organizational culture, which increases their ability to acquire quality workers from the external labor market. In recent years, there has been a trend towards greater mobility of staff (especially within the European Union).

Employers on the basis of many factors select potential job seekers. Nevertheless, not everyone is interested in the prestige or reputation generated by the index of organizational culture and the concept of Industry 4.0.

Organizational Perspective

From an organizations' perspective, the research outputs are considered in terms of identifying weaknesses or strengths, or opportunities and threats. The research outputs are to also serve for the purposes of comparison between individual competitors, or as a good basis for benchmarking methods to determine organizations' overall quality or prosperity. Using the research outputs may generally help to improve the quality and efficiency of business processes.

Limitations of the study

The survey had several limitations. The selection of respondents is the first limitation. This deficiency is not so crucial, because the Czech Republic currently has a relatively homogeneous socio-economic composition.

Another limitation is that the category of employees with lower levels of education was underrepresented in our sample. In addition, the method of data collection through part-time students may also be a certain limitation. However, this disadvantage was in part offset by the diversification of the jobs that these students have, because they worked in different areas of both the public and the private/government sectors.

Despite these limitations, we believe that our data provide results that expand our understanding of the dimensions of organizational culture at organizations.

6 Conclusion

Industry 4.0 and its influence in the manufacturing sector are well studied and documented, but the same couldn't be said for the service sector, and the service sector is facing some challenges such as mass customization, digital enhancement, smart work environment, and efficient supply chain. (Shamim et al., 2017)

Ellen J. Wallach has classified organizational culture into three dimensions: bureaucratic, supportive, and innovative; where bureaucratic culture is considered to be a prominent hierarchical organization that is highly organized with a clear line of authority defined.

The supportive culture however focuses on interpersonal relationships and it is based on mutual trust, encouragement and co-operation. Innovative culture is considered to be dynamic and it supports creative work, carries new challenges and encourages risky behavior; And this is the type of organizational culture that supports the implementation of Industry 4.0, so if the features of innovative organizational culture according to organizational culture index do prevail in organizations in the Czech Republic then we can say that the organizational culture of Czech organizations is supportive or ready for implementing Industry 4.0.

The Hofstede's dimensions of culture could be used with (or as a support to) the organizational culture dimensions introduced by Wallach. For example those countries, which have high uncertainty avoidance, try to deal with the unanticipated situations with a precisely defined set of rules and as a result they develop systems that are bureaucratic.

Based on the assumption that the Innovative culture is one of the pre-conditions for implementing Industry 4.0 and speculating that innovative culture does not depend on the size and/or the type of the organization, using the Wallach's model and/or Hofstede's Model we can find out what kind of culture are we dealing with when it comes to preparing companies for implementing 4.0, and therefore appropriate strategies according to the type of culture could be set to prepare the companies for smoother and easier transition towards Industry 4.0.

The theoretical results of the research, especially from the outputs of quantitative research and validation of the hypotheses formulated, could be considered as the description and utilization of Wallach's questionnaire and Hofstede's dimensions of national cultures for the purpose of implementing Industry 4.0.

The results of this dissertation will be useful in the creation and adjustment of strategy and methodology for preparing firms for the implementation Industry 4.0, and can increase the efficiency of human resource utilization and consequently the economic outcomes of the firms.

Hofstede's model together with Wallach's model could give us a good idea of the existing organizational climate of the firms and based on this knowledge the appropriate approaches and strategies could be selected in order to make some adjustments and prepare the firms in a way that they will meet the preconditions for implementing Industry 4.0 for an easier and smoother transition.

In the overall assessment (for the whole period 2013-2017) there are obvious differences between different types of companies in all areas. The smallest differences are in the supportive culture, where there is a significant difference only between Czech companies and state organizations.

In the field of innovative culture, the evaluation is markedly the highest among international companies, behind them are Czech companies slightly lagging behind, and with great distance they are state organizations, which makes complete sense.

The null hypothesis were:

$H_0$1: The innovative organizational culture according to the index of organizational culture depends on the size of an organization in question.

$H_0$2: The innovative organizational culture according to the index of organizational culture depends on the type of an organization in question (domestic, international, transnational, state/state-funded).

Based on the statistical analysis there is sufficient evidence to conclude that the innovative organizational culture according to the index of organizational culture does **NOT** depend on the size of an organization. Therefore, the null hypothesis $H_0$1 is **rejected**.

Based on the statistical analysis there is sufficient evidence to conclude that the innovative organizational culture according to the index of organizational culture depends on the type of an organization. Therefore, the null hypothesis $H_0$2 is **NOT rejected**.

In the end, "*Knowledge management cannot exist without knowledge engineering, and knowledge engineering cannot exist without people*" (Markopoulos & Kornilakis, 2016), and

it is up to these very people to decide and promote such an organizational culture, which supports creative work, carries new challenges and encourages risky behavior for better prosperity. The knowledge management literature continually stresses out the indivisible relationship between organizational culture and knowledge management (Rahman et al., 2018), and that a key factor for implementation of industry 4.0.

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8 List of students' publications related to the topic

Mohelská, H. & Ziaei Nafchi, M. (2018). The Correlation of Government Expenditure on Information and Knowledge Systems with Unemployment. In JEDLIČKA, P., MAREŠOVÁ, P., SOUKAL I. *Hradec Economic Days*, Vol. 8(2), (pp. 83-91). Hradec Králové, January 30-31, 2018. ISBN 978-80-7435-701-5

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Appendix:

Výzkum spokojenosti v zaměstnání

Cílem dlouhodobého výzkumu, prováděného na Fakultě informatiky a managementu Univerzity Hradec Králové, je identifikovat faktory ovlivňují spokojenost se zaměstnáním a následně je využít pro další zkoumání. Dotazník je anonymní. Prosíme Vás o vyplnění všech položek dotazníku, popište, jak Vy vidíte organizaci, v které pracujete. Neexistují žádné „správné“ ani „špatné“ odpovědi.

Děkujeme za spolupráci.
doc. Ing. Marcela Sokolová, Ph.D.
za řešitelský tým při FIM UHK

Několik údajů o Vás a Vaší organizaci:

1.1. Pohlaví (zaškrtněte)
☐ muž ☐ žena

1.2. Váš věk: ……

1.3. Vaše nejvyšší dokončené vzdělání (zaškrtněte):
☐ ZŠ ☐ vyučen/a ☐ SŠ ☐ VOŠ ☐ VŠ ☐ studující VŠ

1.4. Velikost Vaší organizace podle počtu zaměstnanců (zaškrtněte):
☐ do 50 zaměstnanců
☐ do 250 zaměstnanců
☐ do 500 zaměstnanců
☐ více než 500 zaměstnanců

1.5. Typ Vaší organizace (zaškrtněte):
☐ česká (český vlastník)
☐ zahraniční (zahraniční vlastník)
☐ nadnárodní společnost
☐ státní, příspěvková nebo rozpočtová organizace

1.6. Kolik let v organizaci pracujete: ……

1.7. Pozice v zaměstnání (zaškrtněte)
☐ řadový pracovník ☐ vedoucí pracovník

1.8. V jaké oblasti podniká/působí Vaše organizace:

……

……

Index kultury organizace Prosím, zakřížkujte možnost, která nejvíce odpovídá Vašemu názoru na organizaci, kde pracujete.		Vůbec ne	Jen částečně	Dosti často	Ve většině případů
2.1.	riskující	☐	☐	☐	☐
2.2.	založená na spolupráci	☐	☐	☐	☐
2.3.	hierarchická	☐	☐	☐	☐
2.4.	procedurální	☐	☐	☐	☐
2.5.	orientovaná na vztahy	☐	☐	☐	☐
2.6.	orientovaná na výsledky	☐	☐	☐	☐
2.7.	kreativní	☐	☐	☐	☐
2.8.	podporující	☐	☐	☐	☐
2.9.	přátelská	☐	☐	☐	☐
2.10.	strukturovaná, hierarchická	☐	☐	☐	☐
2.11.	přetlaková, výbušná	☐	☐	☐	☐
2.12.	vládne zde řád	☐	☐	☐	☐
2.13.	stimulující	☐	☐	☐	☐
2.14.	činnosti jsou zde řízeny a regulovány	☐	☐	☐	☐
2.15.	umožňující osobní svobodu	☐	☐	☐	☐
2.16.	spravedlivá	☐	☐	☐	☐
2.17.	bezpečná	☐	☐	☐	☐
2.18.	kladoucí výzvy	☐	☐	☐	☐
2.19.	podnikavá	☐	☐	☐	☐
2.20.	zavedená, solidní	☐	☐	☐	☐
2.21.	opatrná	☐	☐	☐	☐
2.22.	důvěřující svým zaměstnancům	☐	☐	☐	☐
2.23.	plná nových myšlenek	☐	☐	☐	☐
2.24.	zaměřená na držení moci	☐	☐	☐	☐