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# *Development of organisational competencies during transition and adaptation to industry 4.0.*

**Iryna Bohashko**
*Department of English Philology*
*Dragomanov Ukrainian State University*
Uman, Ukraine
23fif.i.bohashko@std.udu.edu.ua

**Oleksandr Bohashko**
*Department of marketing, management and business management*
*Pavlo Tychyna Uman State Pedagogical University*
Uman, Ukraine
bogashko@ukr.net

***Abstract.*** **Competencies that enable organizations to effectively implement digital technologies and provide them with the ability to adapt to changes in the digital environment can be classified as organizational competencies in the context of digital transformation. During the transition to Industry 4.0, organizations find themselves in conditions of a high level of uncertainty and complexity, which requires them to adapt to the new context. A key factor in this process is competencies that ensure high competitiveness and innovative potential. However, the scientific literature does not sufficiently disclose their content, classification levels, and development opportunities under digitalization conditions. This article attempts to fill this gap by analyzing the impact of new technologies on organizational competencies. A conceptual model is presented, which is based on the assumption that the degree of digitalization strengthens the interaction of higher-level competencies - strategic flexibility and ambidexterity.**

***Keywords: Organizational competencies, Industry 4.0, digitalization, strategic flexibility.***

## I. Introduction

Organizational competencies are skills that “go beyond”. More specifically, it is a type of skill that allows you to learn and create new useful skills faster, and helps improve and develop other abilities that you already have.

Organizational competencies are a higher level of abilities that include a set of general skills that can be applied in different situations and in different areas of the organization. These competencies include, for example, critical thinking skills, communication, creative problem solving, leadership, etc. The main purpose of organizational competencies is to help employees adapt to changes in the work environment and solve tasks effectively.

Enterprises of various industries face the difficult task of adapting to Industry 4.0. The widespread use of digital technologies is transforming workplaces and production processes. Many organizations have already moved to a digital environment in part or in full, while others are still exploring the possible implications of such a move. The time has come when the most innovative tool will be the support of higher-level competencies, in particular *strategic foresight, flexibility and organizational ambidexterity* [1] – [3].

One of the key components of the development of second-level competencies, or “dynamic capabilities”, is the formation of realistic scenarios of the future and the adjustment of strategies. This process plays a critical role in identifying risks and opportunities, responding to new trends and internal transformations [2], [4].

Strategic flexibility allows organizations to execute long-term programs and maintain high maneuverability and adaptability in the face of uncertainty. Ambidexterity involves the ability to combine two opposite processes: current activity and the search for new perspectives. It allows organizations to balance between modernization of current business processes in dominant market conditions and exploration of strategic horizons.

The specified competencies allow solving complex tasks in the context of digital transformation - effectively managing supply chains using real-time demand data processing. The use of technologies of artificial intelligence, virtual and augmented reality, “Internet of things”, cloud computing, analysis of large volumes of data, 3D printing, additive manufacturing and others, provides an opportunity to create a flexible and orderly space that avoids excessive accumulation of inventory.

The use of hardware and software for processing large volumes of data, based on the automated analysis of information received from sensors of devices connected to

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computing systems, contributes to the creation of a reliable basis for the development of competencies that allow reconfiguring production to adapt to various changes. The digital system, while having advantages, raises certain challenges, such as protecting cyber security in a hyper-connected environment. Whether it is possible, in the process of digital transformation, to acquire meta-competencies that will allow preventive response to new opportunities and threats, to show strategic flexibility, foresight and ambidexterity, remains unknown [5]. This study hypothesizes that the level of digitalization enhances the effects of the interaction of higher-level competencies – strategic foresight, strategic flexibility, and ambidexterity.

## II. METHODS

The systematic literature review method is widely used to systematise and summarise knowledge in various subject areas. This approach is based on a detailed analysis of a limited number of scientific studies, is labour-intensive, and takes into account the opinions of experts.

Another common method, bibliometric network analysis, combines both expert and computational approaches to support interpretations and conclusions with quantitative data. This method makes it possible to process much larger volumes of scientific publications and identify relevant topics and promising areas of research.

The use of theoretical and empirical methods allows us to create a more objective reflection of the scientific topic under consideration and identify the links between its various aspects. This is achieved with the help of visual tools: building citation maps, co-authorship and other aspects of scientific activity. This allows for a deeper understanding of the current state and development trends of the topic under study. Consideration of the characteristics of each of these approaches is in favour of their use in the process of writing an article, as they fully meet the purpose of the study.

## III. RESULTS AND DISCUSSION

The introduction of Internet technologies in industrial production marks the beginning of a new era of industrialisation - Industry 4.0. The first industrial revolution (Industry 1.0) is associated with the invention of the steam engine. Industry 2.0 is marked by the introduction of the concept of assembly line production, which was first introduced at Henry Ford's factory. This approach is algorithmic, where the production of a product takes place step by step according to a fixed programme by dividing work functions. Within Industry 3.0, the production process includes industrial robots, which, however, remain static, mostly performing a specific operation according to a programme provided in advance [6].

In Industry 4.0, the production process is effectively regulated through the interaction between personnel, technical equipment, and the transport system. This approach is based on the use of big corporate data, which includes both structured information about the activities of companies and unstructured data from social networks, sensor signals, audio and video data [7].

TABLE 1 CLASSIC 3.0 TECHNOLOGY AND NEW 4.0 TECHNOLOGY

| *Classic 3.0 technology* | *New 4.0 technology* |
|---|---|
| Automation | Artificial intelligence |
| Accounting and dispatching | Cyber security |
| Data storage | 3D Printing |
| Mobile technologies | Drones and other devices |
| Industrial networks | IoT Platforms |
| Cloud computing | Digital twins |
| Robots for process operations | Cobots |
| Industrial automation | Block chain |
| Manufacturing execution system | Wearable |

In Industry 4.0, the production of customised products tailored to consumer preferences at a given time is made possible by integrating technology, production and the market into a socio-technological system that automatically adapts to changing conditions. Data from machines and sensors are analysed, integrated with text documents and help speed up business processes, which will contribute to a fast and efficient decision-making process.

The 4.0 concept defines an intelligent production network where physical production processes are integrated with digital technologies, machine learning systems and big data processing to form a single ecosystem of interconnected companies focused on manufacturing and supply chain management.

The term Industry 4.0 first appeared in 2011 at an industrial trade fair in Hannover, Germany. In different regions of the world, this approach may be known by other names, such as the Industrial Internet in the US and Internet+ in China. The concept is based on four key aspects: cyber-physical systems, the Internet of Things, the Internet of Services, and smart factories. From a technological point of view, Industry 4.0 implies the simultaneous digitalisation and automation of production. These processes lead to a change in modern business models, which began with the creation of digital value chains. The first step in implementing these ideas was the introduction of key technologies for Industry 4.0 (Table 2) [8].

In the field of strategic management, the resource-based view (RBV) has become widely accepted, which states that companies with unique, rare and inaccessible resources and knowledge have a significant advantage [9]. However, there is a lack of information on how to properly use and develop these resources to adapt to new conditions. In order to gain a more complete understanding of this process, the concept of organisational capabilities was proposed. According to this theory, companies respond to challenges by developing internal management skills, technological abilities, etc. instead of trying to influence external factors [10].

TABLE 2 STATE-OF-THE-ART TECHNOLOGY

| ***Technology*** | ***The essence of the technology*** |
|---|---|
| Artificial intelligence and robotics | Developing machines that can replace humans in a wide range of tasks related to thinking, multitasking, and fine motor skills. thinking, multitasking and fine motor skills |
| Networked sensors | Commonly known as the "Internet of Things", this is the use of networked sensors to remotely connect, monitor and control products, systems and networks |
| Virtual and augmented reality | Advances in the relationship between humans and computers that include environmental simulations, holographic readings, and overlays of digital objects environment simulation, holographic readings, and the overlay of digital objects on the real world using mixed reality |
| Additive manufacturing | Advances in additive manufacturing using an increasingly wide range of materials and innovative methods, including 3D bio printing of organic and innovative methods, including 3D bio printing of organic tissues |
| Block chain and distributed technology | A distributed ledger technology based on cryptographic systems that manage, verify and publicly record transaction data. A distributed ledger technology based on cryptographic systems that manage, verify and publicly record transaction data; the basis of "crypto currencies" such as bit coin |
| Advanced materials and nanomaterial | Creation of new materials and nanostructures to develop useful properties such as thermoelectric efficiency, shape retention, and to invent new functional applications |
| Capture, storage and transmission of energy | Breakthroughs in the efficient use of batteries and fuel products; renewable energy through solar, wind and tidal technologies; energy distribution through smart grid systems networks; wireless energy transmission, etc. |
| New computing technologies | New architectural solutions for computer hardware, such as quantum computing, biological computing, biological computing or neural network processing, as well as innovative extensions of current computing technologies |
| Biotechnology | Innovations in genetic engineering, sequencing and therapy, as well as biological computing interfaces and synthetic biology |
| Geo-engineering | Technological intervention in planetary systems, usually to mitigate the effects of climate change by removing carbon dioxide or managing solar radiation |
| Neuro-technology | Innovations such as smart medicines, neuroimaging and bioelectronics interfaces that allow us to read, communicate and directly to detect, communicate and directly influence human brain activity |
| Space technology | Developments that enable greater access to and exploration of space, including microsatellites satellites, advanced telescopes, reusable rockets and integrated rocket and jet engines |

There are four categories of organisational competencies. The first category is the ability to perform core functions. The second category implies readiness for continuous improvement. The third category is defined by the skills of formulating strategies aimed at outperforming competitors in existing markets. The fourth and highest category covers meta-competencies that provide the basis for changing competencies at lower levels.

Meta-competencies, or organisational competencies, are responsible for a higher level of skills and abilities and have a certain hierarchy. This higher level includes *strategic foresight, strategic flexibility and agility, and organisational ambidexterity* [1], [2].

The second level of meta-competencies is called "dynamic capabilities" [11]. It includes: detecting trends, opportunities and threats (sensing); responding to them (seizing); transforming - changing organisational culture, business models, etc.

The dynamic global business environment is characterised by constant changes in consumer behaviour and competition, as well as the introduction of new technologies and innovations. This creates both opportunities and risks for companies of all ages. However, without a higher level of competence, many of the hidden signals may remain invisible. For example, the retail industry is reflecting the growing demand for online shopping, but not all market participants understand the need for digitalisation to meet this demand. The development of the ability to identify depends less on investment in new knowledge than on the internal cognitive mechanism for assessing external signals of a different nature that contain an existential threat or an impulse to update [12]. This meta-competence is especially relevant for the banking sector, where regular stress tests and constant changes in international financial reporting standards force the constant revaluation of assets and modelling of various scenarios [13].

Capturing new phenomena involves, first and foremost, keeping abreast of emerging technologies and markets at different levels [11]. This process requires investing in research on consumer behaviour and assessing the extent to which new developments can meet their needs. The first emerging signals are formalised into categories such as "target market segments" and "promising technologies" [14]. Identifying trends, assessing their nature and potential is much easier if key customers and suppliers are involved in the process.

Analysing opportunities and threats involves developing an appropriate response. Changes in the economic situation require both changes in various production links (manufacturing, services, production processes, etc.) and a revision of the business model as a whole [14]. At the initial stage, it is often necessary to consider several conflicting strategies. While previously the location of an organisation was considered a key strategic asset (e.g. in the retail sector), with the advent of Industry 4.0, the ability to integrate virtual and augmented reality, 3D printing, and data analysis technologies is becoming more important. The complex and contradictory trends that are emerging can only be understood by constantly updating competencies, resources, and investments in research and development (R&D).

The key aspect is to determine the optimal moment for implementing transformation processes in a timely manner. Some businesses, even after recognising new opportunities and risks, remain in their comfort zone, continuing to stick to their old strategies and business models.

A company's evolutionary potential is largely determined by its ability to transform its internal structure and assets in line with market and technological changes. As an organisation grows in size, the number of employees increases, which can lead to negative consequences from insufficient performance discipline. To protect against these consequences, it is necessary to implement strict regulatory procedures and build hierarchical structures, which, however, over time, may limit the readiness to respond quickly to environmental signals and create new knowledge [14].

If there is a lack of openness to change in the corporate culture, this can lead to resistance among employees and result in significant costs. However, transformation processes can be more successful and efficient if a company works with supply chain partners who are open to change. Developing transformation capability requires an understanding of the broader, holistic context. Strategic decision-making should be made at different levels of the hierarchy, taking into account market realities [11].

Thus, high-level organisational competencies are becoming increasingly important in today's business environment.

*Strategic foresight*, as a tool for identifying weak signals, opportunities and risks, and analysing cause and effect relationships, enables informed decision-making taking into account a wide range of factors. It stems from the assumption of a multivariate future and interacts with the identification of emerging phenomena and trends, which is a second-level meta-competency - dynamic abilities [4].

*Strategic flexibility* is an important characteristic that manifests itself in the ability to develop and implement long-term strategies while maintaining high adaptability to changes in the face of uncertainty. This concept is based on key concepts such as “future sense”, resource agility and leadership unity. Initially introduced in the development of national strategies, this approach was later replicated in the business sector and led to the concept of “flexible production”, which emphasises individualisation and the opposite of mass production. This approach has found wide application in the areas of supply chain management, services and management.

Ambidexterity combines operational and strategic components. It can also be understood as the ability to effectively create both incremental and radical innovations. Organisations with ambidextrous characteristics have a high level of cognitive flexibility, as they simultaneously work to optimise existing processes and develop new areas of activity.

The study of the contribution of organisational competencies, including managerial, technological and meta-competencies, to company performance indicators such as productivity, efficiency, internationalisation, intellectual property performance and innovation activity continues to be an interesting and relevant topic. However, only a few authors have deeply explored their impact on competitive advantage [10]. Most scholars focus mainly on certain partial aspects, such as marketing and IT capabilities. Future research will help to better understand the link between dynamic capabilities and higher-level competencies [1].

Although the concepts of strategic agility and ambidexterity are aimed at different aspects of higher-level competencies, they interact with each other and are complemented in the context of practice. There is still an incomplete understanding of the role of digital transformation of organisations in the Industry 4.0 ecosystem in this process.

A study by author [15], based on a survey of 150 medium-sized German engineering companies, shows that ambidexterity and strategic flexibility contribute to the growth effects in terms of competitive advantage. This study concludes that in order to achieve sustainable success, corporations should either favour a strategy of exploring innovation processes to create radically new knowledge, products and services, or combine an exploitative strategy with strategic flexibility. Other studies confirm the positive impact of digitalization on strategic flexibility, sustainability and the ability to overcome challenges [16]. Scientists emphasize that digital technologies open opportunities for organizations to create value. This flexibility includes three interrelated dimensions: customer flexibility, partner flexibility, and operational flexibility. Flexibility promotes a positive relationship between company transformation and technological capabilities in the context of Industry 4.0.

## Conclusions

Thus, higher-level organisational competencies include the ability to lead and manage an organisation at the strategic level, develop development strategies, plan business processes and coordinate the activities of departments. They also include decision-making, problem-solving and collaborative skills with different stakeholders. Knowledge of strategic management, effective communication and leadership is also important for a high level of organisational competence.

The discussion presented here contributes to the development of a conceptual framework in which organisational competencies, interacting with each other, play a key role in ensuring effective performance in the face of uncertainty. Evidence from empirical studies indicates how effective digitalisation is in developing the ability to detect and adapt to changes in a highly competitive environment. The decisions made must be backed up by organisational resources that allow for the transformation of systems, processes and business models.

In addition to the level of digital transformation, uncertainty in the environment, flexibility and rationality in decision-making can have a significant impact. It is important to consider cyber security aspects, as the need to protect information is growing.

The framework outlined in this study is not definitive. A more complete coverage of potential long-term effects may require an analysis of other exogenous and endogenous factors that have not been considered in this paper. The development of a multi-factor conceptual model is complicated in part by the fact that there is no single definition of Industry 4.0 due to the diversity of systems and technologies that make up the industry, although their general composition is known.

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