Possibility of Digital Technology Use to Improve the Efficiency of Economic Entities Interaction

Vladimir Aleksandrovich Kunin and Mikhail Mikhailovich Strelnik

Introduction

The modern stage of economic development is characterized by the presence of two opposite tendencies: the intention of economic entities to cooperate and the isolation of their economic activities. Latest trend is clearly manifested at the macro level in the policy of some countries to protect national markets, and it prevents development of interaction with foreign companies and destroys already established relations increasing business entities risks and affecting the key factors of competitiveness negatively: strategic positioning, operational positioning, efficiency, and innovation potential (Kunin & Tarutko, 2018).

The following forms of business entities interaction are distinguished in the theory and practice of economic activity: cooperation, coordination, and collaboration. The theory of cooperation appeared in the nineteenth century (founders are Ch. Fourier, R. Owen, W. King) and since then has repeatedly transformed in the process of the economic environment, society and the state management changes (Palladina & Voronina, 2014). The International Cooperative Alliance (ICA) defines a cooperative as an autonomous association of persons united voluntarily to meet their common economic, social, and cultural needs and aspirations through a jointly owned and democratically controlled enterprise (International Cooperative Alliance, 2022). The differences between the terms of cooperation, coordination and collaboration are as follows:

V. A. Kunin (✉)
St. Petersburg University of Management Technologies and Economics, St. Petersburg, Russian Federation

M. M. Strelnik
St. Petersburg State University of Economics (UNECON), St. Petersburg, Russian Federation

A. Rumyantseva et al. (eds.), *Challenges and Solutions in the Digital Economy and Finance*, Springer Proceedings in Business and Economics,
https://doi.org/10.1007/978-3-031-14410-3_2

– coordination is the harmonization of joint work, combining of various parts or groups into a single whole to achieve common goals of inter-organizational relationships together (inter-organizational relationships—IOR) (Castañer & Oliveira, 2020), while cooperation is a process of joint work of independent economic entities to achieve a common (agreed) goal in the long term.
– collaboration means voluntary help others to achieve the common goal of the IOR or a particular goal of the participant. Collaboration is usually strategic in nature (Wankmüller & Reiner, 2020; Weaver, 2012).

The development of inter-organizational relationships processes is happening amid the rapid spread of breakthrough digital technologies transforming the methods and technologies of business doing (Makarov et al., 2020) and can become an important tool for strengthening and expanding effective interaction of business entities. Digital Transformation can be understood as the changes in all aspects of human life due to digital technology (Stolterman & Fors, 2004). A study of scientific publications on digital transformation shows the lack of a clear definition of digital transformation areas (Van Veldhoven, 2021). It should be noted that the engine of changes is innovation causing industrial revolutions.

In total, four industrial revolutions are identified by different features: the first revolution is characterized by "mechanization", the second revolution by "mass production", the third revolution by "computerization", the fourth revolution is characterized by "cyber-physical systems" and "Internet of Things" (Sikandar et al., 2021). Industry 4.0 is a term to describe the changes due to the fourth industrial revolution. This concept combines the strengths of traditional industries with cutting edge internet technologies. It embraces a set of technologies that support effective and accurate decision-making in real time through the introduction of various Information and Communication Technologies and the convergence with the existing manufacturing technologies (Schmidt et al., 2015). Digitalization represents a paramount process started some decades ago, but which received a strong acceleration by Industry 4.0 and now directly impacts all the process and manufacturing sectors (Branca et al., 2020). It is important to underline that digitalization is not a simple transfer from "analogic" to digital data and documents. It is rather the networking between the business processes, the creation of efficient interfaces, and the integrated data exchange and management (Bogner et al., 2016).

This paper examines the peculiarities of modern digital technologies use for effective business entities interaction and formulates the principal directions of such high-tech interaction.

Digitalization transformed economic activity by dramatically reducing the cost of data collecting, storing, and processing, and due to a significant increase in computing power (Wysokińska, 2021). The types of digital technologies proposed by different authors is given as a comparison in Table 1.

The differences existing in the understanding of the areas of application and the practical significance of various digital technologies, along with the importance of developing the process of business entities interaction, determine the relevance of

Table 1 The types of digital technologies (DT)

The types of DT by C.Vite, R. Morbiducci:	The types of DT by L.V. Tashenova etc.:
Autonomous robot	Internet of things
Simulations	Big data
Integrated systems	Blockchain
Internet of things	Cyberphysical systems
Cybersecurity	
Cloud computing	
Additive manufacturing	
Augmented reality	

Source: made by the authors based on (Vite & Morbiducci, 2021) and (Tashenova et al., 2019)

the research carried out in this article aimed at identifying the prospects of digital technology use to improve the efficiency of economic entities interaction.

Materials and Methods

The methods of comparative analysis, synthesis, grouping, and fuzzy logic are used in the article. Comparative analysis provides an opportunity to identify and group the essential features of digital technologies in the process of interaction between economic entities and to determine possible restrictions of their use.

The fuzzy logic method allows to obtain the probability distribution of digital technology choice based on the distribution of fuzzy sets. The probability distributions of the choice of digital technology by risk accepting people and risk avoiding people were obtained. The decision-making on the choice of digital technology by decision-makers (subjects) is examined in the article.

Results

There is little systematization of digital technologies in scientific publications which makes it difficult to determine their significant properties and areas of practical application. The classification system of digital technologies proposed in this paper is given in Table 2. This classification does not include information and telecommunication digital technologies (chat bots, internet platforms, social networks etc.), since there is no doubt that they can be applied in the interaction of business entities.

This authors' classification is based on three criteria: the level of digital technology specialization, the types of economic activity, the level of interaction between business entities. The authors propose to distinguish general digital technologies that can be applied as a basis for other technologies and special ones, limited by a certain field of application. The application of the type of economic activity as the

Table 2 The classification of digital technologies

№	Digital technology name	Level of digital technology specialization	Types of economic activity	Level of interaction between economic entities
1.	Autonomous robots	Special technology	P; C; S; W	B2B; B2C; B2G
2.	Simulations	Special technology	S; W	
3.	Integrated systems	Special technology	P; C; S; W	B2B; B2C; B2G
4.	Internet of things	Special technology	P; C; S; W	B2B; B2C
5.	Cybersecurity	Special technology	P; C; S; W	B2B; B2C; B2G
6.	Cloud computing	General technology	P; C; S; W	B2B; B2C; B2G
7.	Additive manufacturing	Special technology	P	B2B
8.	Augmented reality	Special technology	C; S; W	B2B; B2C
9.	Big data	General technology	P; C; S; W	B2B; B2C
10.	Machine learning	General technology	P; C; S; W	
11.	Blockchain	General technology	P; C; S; W	B2B; B2C; B2G
12.	Cyberphysical systems	General technology	P; C; S; W	B2B; B2C; B2G

Source: made by the authors.* The types of economic activities: production (P), commerce (C), provision of services (S), performance of work (W). The level of interaction between business entities: Business to Business (B2B), Business to Consumer (B2C), Business to Government (B2G)

classification criterion involves the use of digital technology in the interaction of entities engaging the certain economic activity (production, commerce, provision of services, performance of work). The level of interaction of economic entities presupposes the allocation of the following levels: interaction between businesses; interaction between business and consumer; the relationship between business and government.

Cloud computing, big data, machine learning, blockchain, cyberphysical systems are classified as general technologies in the article. It is possible to get mobile access to big data stored on a digital platform or to machine learning tools with the help of cloud computing. Cloud computing along with blockchain can be used for mobile control of business processes implementation, the passage of transactions etc. Such complex application of digital technologies is reasonable to recommend in practices when implementing such form of interaction between business and the government as public-private partnership (Kunin & Semenov, 2021). Some digital technologies are special, for example, additive manufacturing, which is the process of joining materials to make parts from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing and formative manufacturing methodologies (ISO/ASTM 52900-15, 2015).

The following digital technologies can be used in the interaction of economic entities engaged in production, commerce, provision of services (works): autonomous robots, integrated systems, internet of things, cybersecurity, cloud computing, big data, machine learning, blockchain, cyberphysical systems. The finished goods that can be commercialized are not the result of simulator use. Therefore, the possibility of using this technology should be considered in the interaction of entities providing services or performing works. The use of additive technologies is possible only in the interaction of industrial entrepreneurship entities. Entities operating in the field of commercial entrepreneurship, providing services and performing works can apply augmented reality. The authors of the article suppose that the application of big data and machine learning is expensive, but large enterprises can usually afford it. However, when large and small enterprises interact under the sub-contracting scheme, the large enterprise (subcontractor) working together with small enterprises can provide them with the necessary support in the use of digital technologies. At the same time, big data and machine learning is equally important to apply in the field of commerce, provision of services (performance of work) where business entities carry out active interactions with the external environment which leads to the generation of big data.

The use of additive manufacturing technology is possible in B2B interaction. Internet of things, simulators are possible in the event of B2B and B2C interactions. The rest of digital technologies can be applied at all levels of interaction between economic entities: B2B; B2C; B2G.

An important consequence of digital technologies use in business entities interaction is the potential of significant efficiency increasing of economic activity and the competitiveness of the participants of such interaction. The use of digital technologies allows interacting subjects to increase labor productivity and the quality of goods, services or works performed. This leads to revenue increase of the interaction participants. Revenue increase can be accompanied by fixed costs increase and will be effective if the growth rate of fixed costs is less than the critical value determined by the following formula:

$$\kappa_{\mathrm{f}}^{(crit)} = \frac{bc}{f} - (c - 1), \tag{1}$$

where

$\kappa_{\mathrm{f}}^{(crit)}$—critical value of fixed costs growth rate.

b—revenue growth rate.

c—basic position determined by the ratio of revenue to revenue at the break-even point.

f—a parameter determined by the change in the share of variable costs in revenue, and equal to the ratio of marginal profit before and after the revenue change (Kunin, 2015).

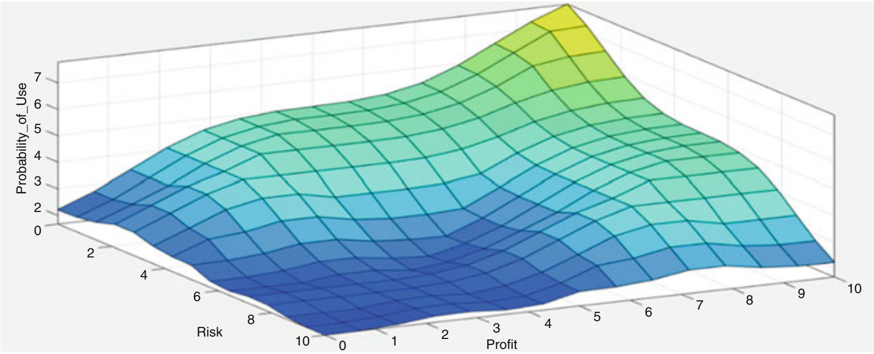

Fig. 1 The distributions of probability of digital technologies choice by a risk avoiding person. Source: authors' development

If condition one (1) is met, it means that revenue growth is accompanied by sales profit and economic profitability increase, therefore, the efficiency of economic activity is going up.

Based on Fuzzy Logic Toolbox (MATLAB extension package for designing fuzzy logic systems), an expert system can be developed that determines the probability of digital technology choice by economic entity deciding of particular digital technology to be used for interacting with other entities.

The following factor indicators are considered:

– the risk level of digital technology application.
– the profit from the digital technology use.

It should be noted that risk can appear because of management decision. (Strelnik, 2014). The resulting indicator is the probability of deciding on the digital technology choice. The following assumptions are made:

– the range of factor indicators values is from 0 to 10 (where 0 is the minimum value, 10 is the maximum value).
– the distribution of factor indicator function is normal.

The distributions of probability of digital technologies choice by a risk avoiding person is presented in Fig. 1.

It should be noted that if the person making a decision on digital technology use avoids taking risks, the probability of digital technology choice will be minimal with high risk level of digital technology application, as well as with minimal values of profit. As profit rises and risk level declines, the probability of choice of a given digital technology grows.

The distributions of probability of digital technologies choice by a risk accepting person is shown in Fig. 2.

If the decision maker accepts risk, the probability of digital technology choice will grows in proportion to rising profits from the use of digital technology in order to build relationships of interaction with other business entities, even if the risk level

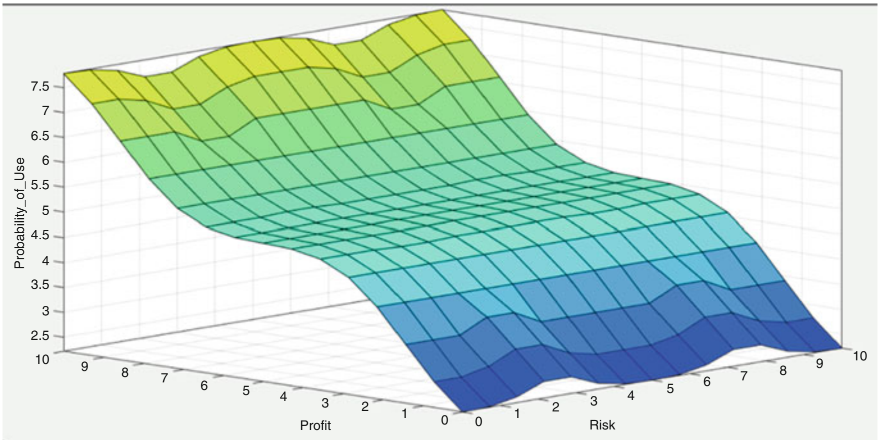

Fig. 2 The distributions of probability of digital technologies choice by a risk accepting person. Source: authors' development

of digital technology application rises. The probability of digital technology use declines if the profit from the digital technology use decreases. The advantage of fuzzy logic use in expert system consists in the universal validity of its application and individuality in setting a type of the distribution of factor indicator, choice of performance indicators and generation of selection rules used by the decision-maker.

Generation of databases on assessments of the probability of choice of a particular digital technology for different scenarios of attitudes towards risk of decision makers and subjects of different economic activities with different scales of economic activity allows:

– to reveal the prospects of the digital technologies, use in business interaction.
– to determine key areas of technological support for such kind of interaction.

Discussions

The economic entities are increasingly using modern digital technologies in internal business processes. At the same time, when several economic entities interact, the barriers impeding the effective use of digital technologies for the development of interaction may arise. The classification of digital technologies which makes it possible to determine their properties in the case of their application in economic entities interaction is presented in the article. Thus, it becomes possible to assess the restrictions of the use of digital technologies proactively.

In this regard, the importance of the development of interaction technologies based on the use of cloud technologies and low code platforms for wide access, providing the relative ease of use and mobility of access should be emphasized. Such platforms are able to provide the possibility of easy mobile access to digital services and software products for a wide range of users of interacting organizations. They can provide access to databases and software for their processing, including the use of machine learning methods.

The digital technology choice depends on the criteria applied by a decision maker. Apart from technology, digital transformation includes the activities of an actor (for example, a manager) involved in promoting transformation processes (Mikhaylova, 2019; Nadkarni & Prügl, 2021).

Today, the connection between cloud technologies and the internet of things is possible which opens the possibility of combining classical artificial intelligence with advanced approaches of machine learning (Alberternst et al., 2021).

There is the possibility of augmented reality technology use in commerce. The application of augmented reality as exemplified by food and beverages allows:

- to track products in the supply chain helping to identify goods counterfeiting, especially in international markets.
- to inform consumers about product characteristics (Penco et al., 2021).

Digital technologies have also become widespread in government management. For example, since 2014, the concept of electronic residency ("e-Residency") has been implemented in Estonia. This concept implies the possibility for other countries citizens to receive an e-resident ID card giving access to government services: online registration of an e-business, opening of a bank account etc. Thus, the government can expand its capabilities by attracting new residents - potential consumers of state services (individuals and legal entities) (Mikhaylova, 2019).

The probability of digital technology choice in business entities interaction, depending on two factors is considered in the article: the risk level of digital technology implementation and profit from the digital technology use. The authors admit the existence of other factors that can affect the digital technology choice in economic entities interaction. For example: the required level of user competence; the amount of investment required for digital technologies introduction; the possibility of digital technologies use by all interacting subjects etc. Nevertheless, it is possible to consider these parameters as additional variables in Fuzzy Logic Toolbox, setting the appropriate distribution laws for their values, and get the probability distribution for digital technology choice based on the criteria.

New technologies lead to changes in the factors of production which, in their turn, can contribute to the emergence of new innovations. For future studies, the most relevant option is to consider the evolution of digital technologies in the aspect of economic systems transformation.

Conclusion

The classification system presented in the article makes it possible to determine the essential features of digital technologies use in of economic entities interaction in accordance with the following criteria:

- the level of digital technology specialization.
- the types of economic activity.
- the level of interaction between economic entities.

There are restrictions of digital technology use in business entities interaction. The use of fuzzy logic for the expert system makes it possible to determine the probability of decision making on the choice of digital technology in interacting with other economic entities based on such factor indicators as the risk level of digital technology application and profit from the digital technology use.

The use of digital technology is reasonable not only at the level of internal business processes, but also in economic entities interaction. At the same time, the complex application of digital technologies and cloud computing and low code platforms aimed at providing easy mobile access for users of interacting entities, helps to overcome the barriers and increase the efficiency of interaction between economic entities with different scales of economic activity.

References

Alberternst, S., Anisimov, A., Antakli, A., Duppe, B., Hoffmann, H., Meiser, M., et al. (2021). Orchestrating heterogeneous devices and AI services as virtual sensors for secure cloud-based IoT applications. *Sensors, 21*(22), 7509. https://doi.org/10.3390/s21227509

ASTM I (2015). *ASTM52900-15 standard terminology for additive manufacturing—general principles—terminology*. ASTM International, West Conshohocken, PA, 3(4), 5.

Bogner, E., Voelklein, T., Schroedel, O., & Franke, J. (2016). Study based analysis on the current digitalization degree in the manufacturing industry in Germany. *Procedia Cirp, 57*, 14–19.

Branca, T. A., Fornai, B., Colla, V., Murri, M. M., Streppa, E., & Schröder, A. J. (2020). The challenge of digitalization in the steel sector. *Metals, 10*(2), 288. https://doi.org/10.3390/met10020288

Castañer, X., & Oliveira, N. (2020). Collaboration, coordination, and cooperation among organizations: Establishing the distinctive meanings of these terms through a systematic literature review. *Journal of Management, 46*(6), 965–1001. https://doi.org/10.1177/0149206320901565

International Cooperative Alliance. (2022). *What is a cooperative?* Retrieved from https://www.ica.coop/en/cooperatives/what-is-a-cooperative

Kunin, V. A. (2015). Business performance management in conditions of economic instability, UchenyezapiskiMezhdunarodnogobankovskogoinstituta. *In the International Banking Institute, 11*(2), 87–97.

Kunin, V. A., & Semenov, A. V. (2021). On the issue of ways to increase the social orientation of public-private entrepreneurship. *Problems of the Modern Economy*, *2*(78), 93–98. (In Russ.)

Kunin, V. A., & Tarutko, O. A. (2018). The system of indicators of the competitiveness of entrepreneurial structures. *Problems of the Modern Economy, 1*(65), 65–68.

Makarov, M., Ivleva, E., Shashina, N., & Shashina, E. (2020, April). Transforming entrepreneurship factors and technologies in the digital economy. In *Proceedings of the III International Scientific and Practical Conference «Digital Economy and Finances»(ISPC–DEF 2020)*. https://doi.org/10.2991/aebmr.k.200423.005.

Mikhaylova, A. (2019). The role of innovations in providing economic security: The Estonian case. *Contemporary Europe, 7*, 136–147. https://doi.org/10.15211/soveurope72019136147

Nadkarni, S., & Prügl, R. (2021). Digital transformation: A review, synthesis and opportunities for future research. *Management Review Quarterly, 71*, 233–341. https://doi.org/10.1007/s11301-020-00185-7

Palladina, M. I., & Voronina, N. P. (2014). The origins of the cooperative theory, cooperatives and the development of the cooperative movement. *State and Law, 4*, 83–95.

Penco, L., Serravalle, F., Profumo, G., & Viassone, M. (2021). Mobile augmented reality as an internationalization tool in the "Made In Italy" food and beverage industry. *Journal of Management and Governance, 25*, 1179. https://doi.org/10.1007/s10997-020-09526-w

Schmidt, R., Möhring, M., Härting, R. C., Reichstein, C., Neumaier, P., & Jozinović, P. (2015, June). Industry 4.0-potentials for creating smart products: empirical research results. In *International conference on business information systems* (pp. 16–27). Cham: Springer.

Sikandar, H., Vaicondam, Y., Khan, N., Qureshi, M. I., & Ullah, A. (2021). Scientific Mapping of Industry 4.0 Research: A bibliometric analysis. *International Journal of Interactive Mobile Technologies, 15*(18). https://doi.org/10.3991/ijim.v15i18.25535

Stolterman, E., & Fors, A. C. (2004). Information technology and the good life. In *Information systems research* (pp. 687–692). Boston, MA: Springer.

Strelnik, M. (2014). Approving the ISDWIR Method of Risk Measurement in Making Risk Management Decision//Aprobación del método de medición del riesgo SIIPDR en el manejo de asunción de riesgos. *Revista de Métodos Cuantitativos para la Economía y la Empresa*, 17, áginas-42.

Tashenova, L. V., Babkin, A. V., & Mamrayeva, D. G. (2019). Digital transformation of industrial production in the context of Industry 4.0, Bulletin of Karaganda University. *Economy Series, 96, 4*, 154–162.

Van Veldhoven, Z. (2021). A scoping review of the digital transformation literature using scientometric analysis. In *2021: 24th International conference on business information systems*. https://doi.org/10.52825/bis.v1i.49.

Vite, C., & Morbiducci, R. (2021). Optimizing the sustainable aspects of the design process through building information modeling. *Sustainability, 13*(6), 3041. https://doi.org/10.3390/su13063041

Wankmüller, C., & Reiner, G. (2020). Coordination, cooperation and collaboration in relief supply chain management. *Journal of Business Economics, 90*(2), 239–276. https://doi.org/10.1007/s11573-019-00945-2

Weaver, B. (2012). *Coordination, cooperation, and collaboration: Defining the C3 framework*.

Wysokińska, Z. (2021). A review of the impact of the digital transformation on the global and European economy. *Comparative Economic Research. Central and Eastern Europe, 24*(3), 75–92.