https://doi.org/10.1051/bioconf/202413008015

Business ecosystem formation ontological mechanism

Viktor Medennikov [1*]

[1] Federal Research Center «Computer Science and Control» of the Russian Academy of Sciences, Vavilova 44-2, 119333, Moscow, Russia

Abstract. The goal of the work is to develop a scientifically based ontological mechanism for the formation of business ecosystems, the terminology of which has emerged as a result of the manifested basic principles of digital transformation of the economy, science and education. It is shown that these principles make it possible to determine the mutual influence of many more factors in the planning and management of business, including scientific and educational. In other words, there was an order to study both classical agricultural ecosystems and the transfer of natural ecosystem mechanisms to the functioning of economic systems, which, together with the possibility of integrating environmental factors and taking into account their interrelationships in a digital economy, led to the emergence of such research areas in the field of ecosystems as business ecosystems. The above principles have led to the development of mechanisms for the integration of information resources not only within one industry, but also in most related industries, for which ontological modeling of their subject spaces should be carried out, the conceptual description of which has become significantly different over the years. Research in this area has been carried out using agriculture as an example, since it is one of the most powerful ecosystems in the classical sense and is closely related to a large number of other industries.

1 Introduction

The world trends and basic principles of digitalization of the economy are discussed in [1], of which in this paper we will need the following two:
- transition in possibility to widespread integration of disparate data into a unified data management system, when the necessary information is collected, processed, stored and applied in a unified format for most economic entities;
- transition to new organizational forms and technologies of both production and personnel management.

The paper shows that these principles significantly increase the efficiency of digital inter-industry interaction of all its participants, while the lack of integration of information resources (IR) and algorithms for their processing are an obstacle to the full-fledged digital transformation of the economy. This is due to the fact that currently in the country each

* Corresponding author: dommed@mail.ru

© The Authors, published by EDP Sciences. This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (https://creativecommons.org/licenses/by/4.0/).

enterprise, each scientific and educational institution operates its own ontologies, not to mention the differences in this issue in inter-sectoral interaction, which leads to departmental disunity and ineffective implementation of integration projects, otherwise - digital feudalism. For example, in agriculture, the non-complex, non-systematic introduction of precision farming technologies (PF) against the background of the traditional conservatism of the sector often does not lead to the promised economic results [2, 3, 4].

The realization of the consequences of a complex transition to integration procedures against the background of significantly increased digital research capabilities of ecosystems (ES) led to the fact that this terminology began to acquire a global scale with the following classification nuances: the search for an optimal balance between the sustainability of ES and human activity; the search for conditions for transferring the laws of functioning of natural ES to social, economic, and educational spheres, i.e. to the degree of their ability to preserve or adapt to changing conditions; and the search for a new definition of ecosystems as business ecosystems. The third direction of research is the most widespread and is defined as business ecosystems.

Taking into account the scale of organizations involved in global value chains, the sharp increase in the cost of the digital economy in the world, the trends in the development of agricultural production and all its branch science to the transition to the production of biological products with the minimization of environmental hazards to the environment and human beings, studies on the formation of an effective ontological mechanism for the functioning of business ecosystems, that is, a unified conceptual space become relevant.

2 Materials and methods

Agriculture is a complex dynamic system, comprising about 25% of the planet's biodiversity, with close linkages to many national and global economic sectors and a large number of subsystems, leading to serious management challenges. For example, in studies [5] The cognitive matrix consisting of 946 factors, ontologically unified, describing only crop production, and only in commodity farms and allowing to visualize the considered system of crop production. These factors are obtained by ontological knowledge space construction methods, or otherwise by ontological modeling. This approach is used to describe and integrate knowledge about subject areas. Ontology is a method of representation of the investigated area of knowledge in the form of a conceptual model that provides unambiguous interpretation of concepts with description of relations between them, with structuring of knowledge and meaning of information. It provides integration of RI and applications of their processing.

Fig. 1 provides an illustration of the need for ontology modeling using the example of two tasks that use some set of overlapping data A and B that need to be understood and interpreted in the same way. The emergence of the concept of business ecosystem, as noted above, was a response to the attempts of many organizations in their digitalization to resort to the integration of disparate data into a single structured cloud environment, when due to the accumulation of a large amount of structured data it became possible to take into account the interrelationships and environmental factors of many managed systems with elements of strategic management [6]. Most of the research in terms of business ecosystems is based on this principle. James F. Moore, who clearly grasped the new possibilities of CE in business and laid the foundation of this theory, writes: "Like natural ecosystems in business, the ecosystem is an economic community based on interacting organizations and individuals, the organisms of the business world. That is, the ES of any enterprise, in addition to itself, includes consumers, market intermediaries, suppliers, as well as structures whose interests must be taken into account in a particular situation - government agencies

 https://doi.org/10.1051/bioconf/202413008015

and regulatory agencies, associations and organizations that ensure compliance with laws and standards. To varying degrees, the ES includes direct and potential competitors, as well as any other influencing members of the system. And the behavior of all these elements must be taken into account, both operationally and strategically, when building information exchanges" [7].

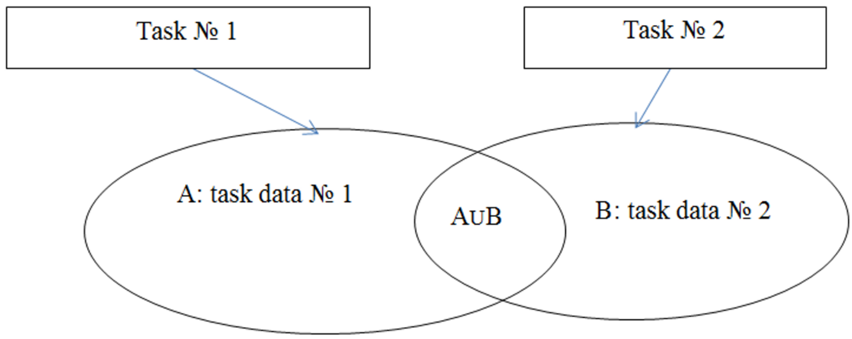


Fig. 1. A diagram illustrating the concept of ontology modeling. Compiled by the author.

The theoretical basis for the emergence of business ecosystems is the conceptual disagreement between two groups of ES researchers in terms of finding conditions for transferring the mechanisms of natural ES functioning to many aspects of human activity, in particular, the ability of ES to preserve or adapt to changing environmental conditions. Some believe that nature in the course of long evolution has already found optimal solutions to all those problems that stood for the survival of biological species through the formation of an appropriate ecosystem. Therefore, at the stage of digitalization, mankind should focus on finding scientific and technological innovations that have a counterpart in natural ES. Others argue that by accumulating a large number of structured data and developing tools for their processing, in particular, in the form of artificial intelligence, mathematical models of management, society is able to develop such strategic solutions, which nature has not tried, and it could not find, for it is not capable of these options from the theoretically possible. That is, nature, in the language of management theory, is capable only of operational management.

The analysis of the experience of digital transformation of production sectors in developed countries convinces that science and education play a significant role in this process, which should fulfill a triune role: support for scientific research, increasing the level of education (sometimes through retraining) for all segments of the population, an effective system of transfer of scientific and educational knowledge into the economy through unrestricted access to this knowledge not only to traditional users represented by researchers, students and teachers, but also to future applicants Thus, science, as well as education, should also be attributed to one of the complementary assets affecting the viability of business ecosystems [8, 9].

3 Results and discussion

The rapid emergence of the digital economy (DE) in agriculture against the background of the usual conservatism of the industry has led to the formation of a significant digital divide between the traditional course of scientific research and the needs of agricultural business in new effective PF technologies, the implementation of which requires the integration of a huge number of structured scientific and production data. In order to resolve this contradiction and to accelerate digital transformation in developed countries, the so-called Innovation Development Centers have been established, one of the tasks of which is to develop digital standards in terms of data and algorithm integration with the resolution of ontological problems as well.

The most obvious example of such integration of scientific research data in the world is demonstrated by the results of the discovery of complementarity in the soil of plants and biota in terms of mechanisms of nutrient use efficiency comparable to waste-free production, when cultivated plants obtain them not only from fertilizers, but also through the interaction of crops with both bacteria and fungi, as well as by providing their nutritional needs at the expense of other organisms, by independently providing their nutritional needs. An integrated approach to such research also requires ontological modeling of the content of field experiments carried out by different research institutes (RI). If we take into account that as a result of science reform there are still 153 agrarian research institutes, the scale of the forthcoming work in this direction is obvious. Then Fig. 2 provides an illustration of the need for ontological modeling of data and algorithms for conducting research in this case.

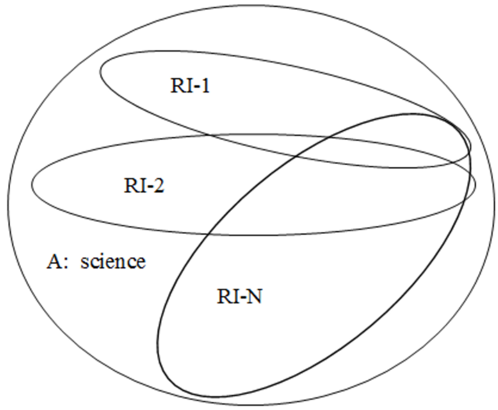
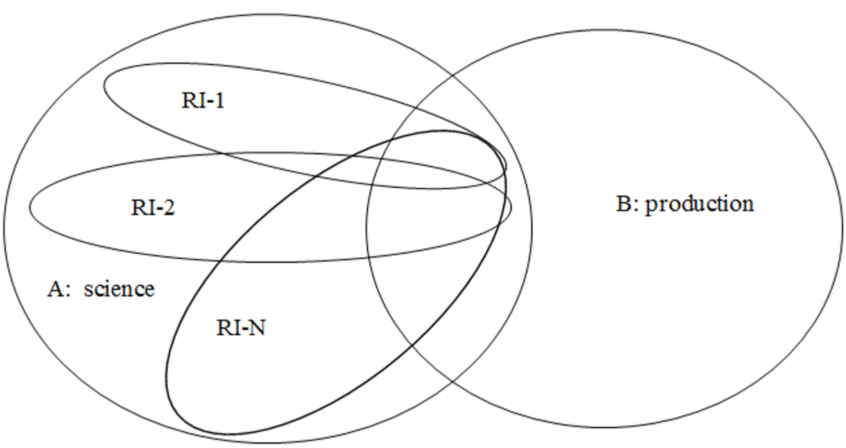


Fig. 2. A diagram illustrating the need for ontological modeling of scientific research. Compiled by the author.

Fig. 3 provides an illustration of the need for ontology modeling of scientific and production data and algorithms.



 https://doi.org/10.1051/bioconf/202413008015

Fig. 3. A diagram illustrating the need for ontology modeling of scientific and production data and algorithms. Compiled by the author.

As a unified digital tool for solving integration and ontological problems in business, the paper [5] proposes a unified digital management platform (DMP) of the production economy, confirmed by mathematical modeling. DMP includes cloud database ("database") (the first digital standard) for collecting and storing primary accounting information (Fig. 4); cloud database (the second digital standard) for technological information; cloud knowledge base in the form of proven management algorithms (the third digital standard). While the first standard shown in Fig. 4 is universal for all industries of the country, the others are only industry-specific.

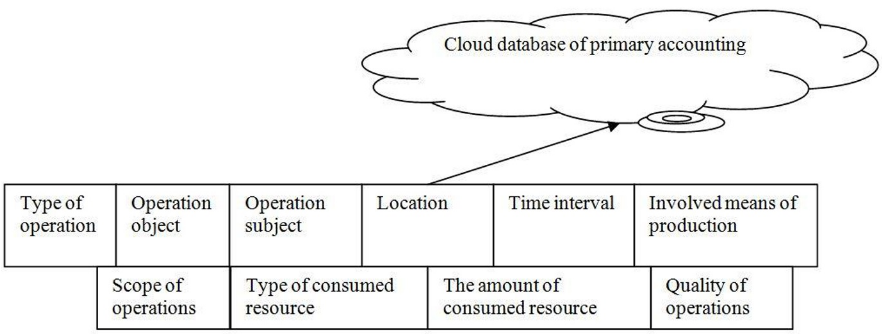


Fig. 4. A cloud-based database for collecting and storing primary accounting information. Compiled by the author.

Then taking into account the above, Fig. 5 presents the integration ontological mechanism of business-ecosystems functioning.

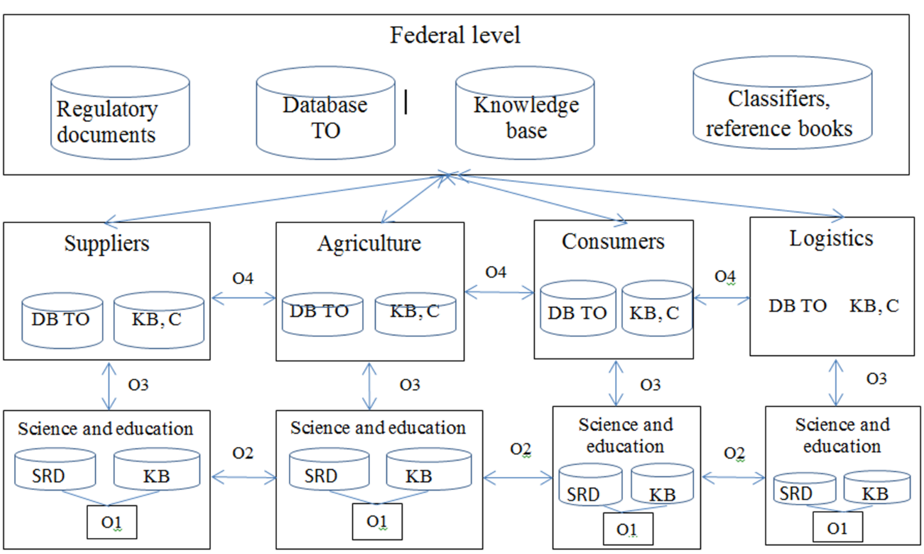


Fig. 5. Integration ontological mechanism of business ecosystems functioning. Compiled by the author.

SRD is defined here as scientific research database, KB – knowledge base, DB TO – database technological operations, C – classifiers, directories, dictionaries. O1 refers to the procedure of ontological modeling among sectoral scientific and educational institutions (Fig. 2). O2 refers to the procedure of cross-industry ontology modeling among scientific and educational institutions, which is similar to the scheme of Fig. 2. O3 refers to the procedure of intra-industry ontology modeling of data and algorithms of scientific and educational institutions and businesses (Fig. 3). Under O4 is the procedure of inter-industry ontology modeling of production technological operations (Fig. 4). Of course, in this case, each industry should develop unified industry classifiers, directories, and dictionaries. It should be noted that the unified DMP, implemented in all industries, allows to collect, in addition to the data of the Internet of Things, information on all technological operations performed according to a single format, which will make it possible to realize the concept of traceability of goods. Currently, traceability is understood as a digital tool that makes it possible to reliably inform partners, regulatory authorities, as well as the end user about the manufacturer, terms, quality, price and other characteristics of the goods. This approach is most in demand in the food and drug industries.

Finally, at the federal level, there should be databases and knowledge bases integrating unified federal classifiers, directories, dictionaries, all regulatory documents, standards, etc.

4 Conclusion

Based on the significant principles of digital transformation of economy, science and education on the example of agriculture, the paper presents a scientifically based ontological mechanism for the formation of business ecosystems, which allows comprehensive integration of information production and scientific and educational resources not only within one industry, but also in most other sectors of the economy. This will allow to strategically and operationally manage business with the most effective innovative solutions with clear trends of transition to environmentally friendly production of products and minimization of negative impact of natural and anthropogenic factors of environmental hazards on the environment, on people themselves.

References

1. V. Medennikov, Yu. Flerov. *System Analysis of Digital Ecosystem of Russian Agriculture*. IEEE Xplore Digital Library. 15 International Conference on MLSD'2021, Moscow, Russia (2022).
2. A. Walter, R. Finger, R. Huber, N. Buchmann, Proc. Nat. Acad. Sci. USA. **114(24).** 6148–6150 (2017). https://doi. org//10.1073/pnas.1707462114.
3. Arun Kumar K C, Obi Reddy G P, Masilamani P, Satish Y Turkar & Sandeep P., Advances in Space Research **67(1)** 298-315 (2021). doi.org/10.1016/j.asr.2020.10.003
4. Boori M.S., Choudhary K., Kupriyanov A.V. *Crop growth monitoring through Sentinel and Landsat data based NDVI time-series*. Computer Optics. **44(3),** 409-419 (2020). doi: 10.18287/2412-6179-CO-635
5. V. Medennikov, E3S Web of Conferences, **420**, 03002 (2023). DOI: https://doi.org/10.1051/e3sconf/202342003002
6. Vladimir Kulba, Viktor Medennikov. *Product Traceability Digital Tool Powered by Mathematical Model for Logistics Digital Platform.* IEEE Xplore Digital Library. 15 International Conference Management of Large-Scale System Development (MLSD), Moscow, Russia (2022).
7. Moore J. *The Death of Competition: Leadership and Strategy in the Age of Business Ecosystems.* Harper Business (1996).

https://doi.org/10.1051/bioconf/202413008015

8. Milgrom P., Roberts J.. American Economic Review **80**. 3. 511-528 (1990).
9. Erik Brynjolfsson, Lorin Hitt, Shinkyu Yang. *Intangible Assets: Computers and Organizational Capital*. Brookings Papers on Economic Activity, **2,** 1 (2002).