

Scientific article

UDC 330.47

DOI: <https://doi.org/10.57809/2022.1.1.2>

INTEGRATION OF INFORMATION AND MANAGEMENT TECHNOLOGIES

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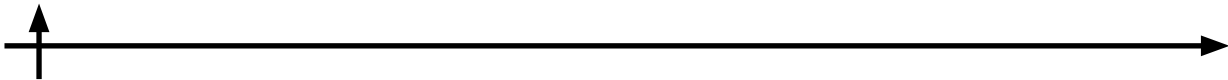
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Abstract. Integration of management and information technologies is a task of increasing relevance for enterprises of all types, especially in view of the work in the changing world around us. This article reviews the state of affairs in this area and provides an overview of the current state of practice-oriented, research and educational approaches. It also describes the work of the Graduate School of Business Engineering (GSBE) of Peter the Great St. Petersburg Polytechnic University and describes the capabilities of Technoeconomics journal, which is created to exchange expert opinion and experience for the development of approaches to the integration of management technologies and IT.

Keywords: business engineering, business informatics, digital technologies, industry 4.0, enterprise architecture, education

Citation: Ilin I.V. Integration of information and management technologies. Technoeconomics. 2022. 1 (1). 24–32. DOI: <https://doi.org/10.57809/2022.1.1.2>

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Научная статья

УДК 330.47

DOI: <https://doi.org/10.57809/2022.1.1.2>

ИНТЕГРАЦИЯ ИНФОРМАЦИОННЫХ И УПРАВЛЯЮЩИХ ТЕХНОЛОГИЙ

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Аннотация. Интеграция управленческих и информационных технологий является задачей все более актуальной для предприятий всех типов, особенно с учетом работы в меняющемся мире вокруг нас. В данной статье рассматривается состояние дел в этой области и дается обзор современного состояния практико-ориентированных, исследовательских и образовательных подходов. Также описывается работа Высшей школы бизнес-инжиниринга (ВШБИ) Санкт-Петербургского политехнического университета Петра Великого и описываются возможности журнала «Техноэкономика», который создан для обмена экспертным мнением и опытом для разработки подходов к интеграции управленческие технологии и ИТ.

Ключевые слова: бизнес-инжиниринг, бизнес-информатика, цифровые технологии, индустрия 4.0, архитектура предприятия, образование

Для цитирования: Ильин И.В. Интеграция информационных и управляющих технологий // Техноэкономика. 2022. Т. 1, № 1. С. 24–32. DOI: <https://doi.org/10.57809/2022.1.1.2>

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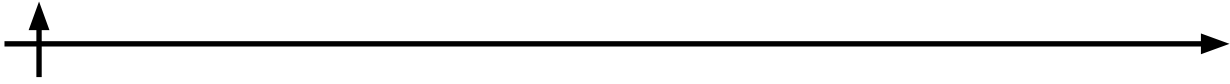
Introduction

Doing business in the information society requires from enterprises a high degree of adaptability to the constantly changing conditions of the environment. Under these conditions, the implementation of the strategic goals of the enterprise should be provided by a flexible and effective management system. The competitiveness of enterprises and countries in a globalized and open economy is largely determined by the management technologies used. Effective use of the latter allows businesses to adapt to changing conditions and respond quickly to the challenges of the macro-environment, thereby strengthening the competitive position of the enterprise in the micro-environment. Management technologies, combined with the opportunities provided by information technology (hereinafter – IT) and digital technologies, not only increase the efficiency of existing company processes, but also provide new tools for business management, allowing to implement processes and implement business models, the existence of which is impossible without the use of appropriate technologies.

This article aims to highlight the current state of development of approaches (in research, educational, and project aspects) in the field of integration of management and information technologies and to explain the relevance of such integration. A separate task of the article is to describe the possibilities of Technoeconomics magazine as a platform for exchanging expert opinion and experience in order to develop approaches in this sought-after direction.

Review

This section provides an overview of the current state of practice-oriented, research and educational directions, established schools and associations of researchers and practitioners engaged in and developing approaches to the integration of management technology and IT.



Business engineering and the concept of enterprise architecture

The role of applied management, information and communication and digital technologies for business success has become quite comparable to the importance of operational technologies, which are aimed at creating the product itself. The implementation of many business models in today's world without automation and digitalization is simply impossible.

When creating an enterprise from scratch, there is a unique opportunity to lay down in the foundation of the created enterprise such technologies, which will be the key to effective business in the future. Here we are talking not only about production technologies, but also about management technologies. In the conditions of globalization and free competition, it is management technologies that are often the key to the competitiveness of enterprises.

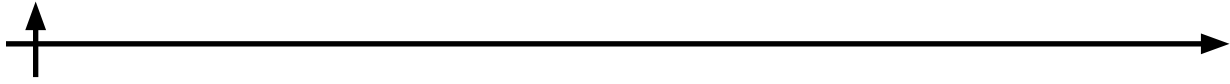
Designing and building a business is a more complex challenge than designing a production. There is still no single recognized standard for business design and creation. To solve these problems, modern organizational technologies, called business engineering, are now being applied around the world, using in management those achievements that work successfully in the design and management of technical objects, and make management accurate and effective. Business engineering is the activity to create, modify or reorganize an enterprise, based on an engineering approach that ensures the consistency of various enterprise components (strategy, structure, processes, information systems). Business engineering integrates and brings to practical solutions the findings of basic disciplines (such as systems approach to the management of organizations, quality management, enterprise architecture management), involves the use of technology (enterprise modeling, knowledge management, decision-making methods), builds on the principles and ideas of several more general disciplines (for example, systems engineering), generalizes the successful practice of real projects (Janssen, 2015).

Business engineering solves the problems of designing efficient enterprises based on the application of "mechanistic" approaches of technological engineering in the creation of socio-economic systems, which have proven their effectiveness in creating control systems of technical objects (Hoogervorst, 2018). The application of such technical approaches makes the process of creation and development of enterprises more accurate and efficient.

In accordance with the postulates of the systems theory, the systems perspective in the design of enterprises declares the need for a holistic view of the enterprise with an emphasis on the relationship between its constituent components (Giachetti, 2016; Röling, 2019). Business engineering relies on the concept of enterprise architecture as a model framework for the created enterprise, integrating heterogeneous classes of business elements. Enterprise architecture defines the overall structure and function of systems (business and IT) across the organization as a whole (including partners and other organizations that form the so-called "extended enterprise") and provides the framework, standards and guidelines for project-level architecture. The enterprise architecture model is designed to bring together technologies to manage various aspects of the business to create an integrated management system (Jaradat et al., 2017).

An important task of the theory and methodology of architectural business engineering is to offer such approaches to the design, implementation and development of management systems that will not only solve the problems listed above in existing enterprises, but also to prevent their occurrence in newly created or modernized (Saharuddin et al., 2019). Application of integrated approach to creation and development of enterprise architecture, which includes IT support as one of the key components, allows to create automated control systems in the context of general enterprise management system and in accordance with strategic goals and objectives of the enterprise.

Significant role of information and communication and digital technologies in modern business is undeniable. The use of information systems and technologies allows reducing time and increasing the efficiency of operations, carrying out effective data collection, processing, storage, transfer, analysis, and thereby improving the quality of management decisions based on the data (Iyamu and Shaanika,



2019). Implementation of information systems without proper coordination with the requirements of the management system is not effective: the requirements of business for IT support of its processes are the driver of the implementation of IT systems at enterprises (El Bilali and Allahyari, 2018; Prokopenko and Omelyanenko, 2018). As a consequence, at one time there was a need for approaches to the formation of an integrated enterprise management system, including IT as an integral part. The answer to the problems of alignment of business requirements and IT capabilities was the concept of enterprise architecture and its broader interpretation – corporate architecture.

The task of business engineering is to integrate into a single methodological complex such components of the enterprise architecture as:

- business processes and BI and ERP systems;
- production processes and MES-systems;
- Manufacturing processes, manufacturing equipment and APCS;
- IT architecture components (BI-, ERP-, MES-systems, APCS);
- Information systems and applications, production equipment (involved in the processes of information exchange of the enterprise) and IT infrastructure;
- implementation of solutions for data collection, storage, processing and analysis.

That is, it is reasonable to talk about the integration of management, operational and information technology within a single model of management system, which is the enterprise architecture model.

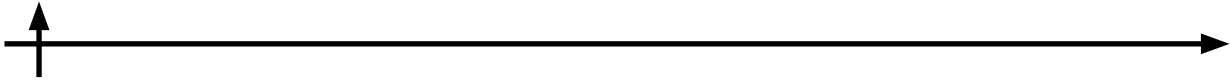
Business informatics as an educational field

Business Informatics (BI) is an interdisciplinary field that provides research and training in both business systems and information systems and technology.

The first training programs related to IT applications in business began to appear at German universities in the 1970s. It was during this period that the term "business informatics" itself emerged, which implied a focus on enterprise data and hardware-software issues. Now business informatics refers to organizations, processes, and the effectiveness of business technology applications (Paul et al., 2018). One of the foundational documents for BI is considered a Business Informatics Memorandum with a focus on creating artifacts (Österle et al., 2010). Well-known scholars in the field such as Peter Mertens, Hubert Oesterle, Jörg Becker, Ulrich Frank, Thomas Hess, Dimitris Karagianis, Helmut Krchmar, Peter Loos, Andreas Oberweis, and Elmar J. Sintz participated in its creation. The Memorandum enshrines basic principles for conducting research that are important in determining the current direction of BI science. Also developed is a Guide to Teaching Business Informatics by authors such as Peter Mertone, Dieter Ehrenberg, and others (Mertens et al., 1999). The first part of the guide defines modern BI. It provides an overview of potential graduate professional fields and forms recommendations for training. The second part of the Guide lists all BI programs at universities in Germany, Austria, and Switzerland. The Guide also provides a general portrait of BI practitioners, including the stories of various company executives and professors who are in one way or another associated with the study, teaching, and application of BI in their professional lives. The guide is significant in terms of contributing to the integrity of the understanding of various aspects of BI.

In Russia, the National Research University Higher School of Economics (HSE) and the School (formerly the Faculty) of Business Informatics initiated the creation and development of this field of study in response to the shortage of qualified personnel capable of effectively organizing complex IP in the commercial and public sectors. Today, BI is taught by more than 180 universities in Russia, and BI issues are discussed at many conferences. BI-related competencies are needed for IT project managers, business analysts, IT directors, and in general for all managers of modern enterprises.

Information Systems is not the only area that BI is concerned with. BI examines a variety of business support methods related to information, organizational, and infrastructure components. As businesses become more dependent on the IT solutions they use, the need for tools to control and monitor performance while solving assigned tasks and using allocated funds increases. At the same time, as IT's



dependence on the business for funding increases, so do the requirements for possible benefits from IT, and the scale of the benefits can range from mere process improvement or automation to the creation and development of new areas of the company's business. In this regard, BI aims to foster dialogue between business and the IT world (Helfert, 2008).

Business informatics is a young scientific and practical direction that exists at the intersection of economics, management and IT. The formation of BI as an academic discipline and all stages of its development were driven by business demand for various applied solutions related to the collection, transmission, storage and processing of information for business purposes. At the moment, the development of BI largely depends on technological trends that have or will have a strong impact on the economy and society.

Thus, it is possible to state that the current position of BI in the economy and science is directly dependent on the needs of modern business. BI interests are shaped by the demand for various scientific applications that are available on the market at any given time. The dynamism of the discipline makes it possible to respond quickly both to the emergence of new technologies and to changes in the practices of commercial companies or in the behavior of consumers and their needs.

Thematic professional communities

There are a number of leading schools of business architecture around the world. A significant contribution to the development of the concept of enterprise architecture has been made by John A. Zachman (Zachman, 2003). Zachman's framework for describing enterprise architecture has served as the basis for a number of other techniques and models for describing enterprise architecture, such as FEAF – Federal Enterprise Architecture Framework, TOGAF – The Open Group Architecture Framework, DoDAF – Department of Defense Architecture Framework. Mark Lankhorst is a key developer of ArchiMate, an enterprise architecture modeling language, and a representative of the Dutch Architecture Forum in the Federation of Enterprise Architecture Professional Organizations (Lankhorst, 2013, 2004). The Open Group are the developers of The Open Group Architecture Framework (TOGAF), a methodology (framework) for describing enterprise architecture, offering an approach for designing, planning, implementing and managing enterprise IT architecture.

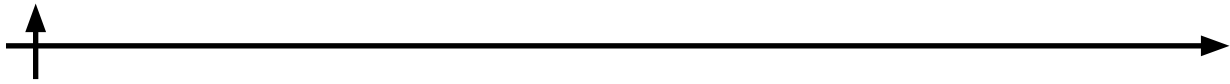
The National Research University Higher School of Economics (HSE) is traditionally widely engaged in the issues discussed. The interdisciplinary scientific journal "Business Informatics" is published.

Modern Management Technologies Group annually holds a unique conference "Designing Business Architectures" for organizational development and business process management professionals. The conference is dedicated to business systems design from conceptual level (description of business system goals, basic functions of business system) to detailed models (processes, organizational structure, material and information objects, personnel requirements, information systems and their functions).

The Graduate School of Business Engineering (GSBE) of Peter the Great St. Petersburg Polytechnic University is a vivid example of an established scientific and educational school in the field of business informatics not only in St. Petersburg, but also at the all-Russian level. The members of the research group actively develop approaches to designing, modeling and creating effective management architectures that meet the requirements of newly emerging business needs, in particular the need to integrate digital solutions and data handling systems into the enterprise architecture.

Conclusion

The effective integration of information and communication and digital solutions is now one of the key challenges of enterprise management. Given the ongoing digital transformation, automation is a necessary prerequisite for the effective transition to new, digital models in the implementation of activities. The implementation of information systems for business management and its individual elements requires a systematic approach, which implies the development of IT solutions in inseparable connection with the formation and development of an integrated enterprise management system. Design



and development of IT-architecture of enterprises requires an appropriate methodological and methodological framework. The task of effective integration of management, operational and information technology is very relevant. In recent years, concepts and models describing the integration of digital technologies into the enterprise architecture have been actively developed.

Given the trends in the concept of the fourth industrial revolution, it is necessary to integrate operational, management and information technologies. The coordinated application of these three technologies is the key to the successful transition to a new way of doing business. Moreover, these types of technologies are consistent with the concept of enterprise architecture and reflect the logic of its formation. This makes the architectural approach a suitable basis for the development of a methodology to integrate these technologies within a single enterprise model. This model will be a development of traditional representations of enterprise architecture, taking into account the factor of digital transformation.

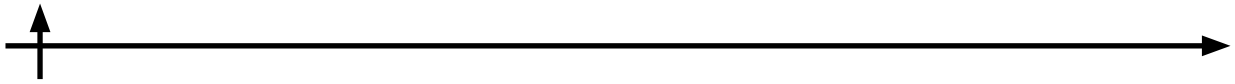
Service-oriented approach is considered as an approach to the formation of a balanced enterprise architecture, which allows to coordinate the mutual requirements of all interrelated layers, allocated in the architecture (Alho and Mattila, 2015; Rabelo et al., 2015). When designing and developing the architecture of the enterprise according to the service-oriented approach, the result of the enterprise activity is business services for external consumers, and the result of the activities of individual layers and elements of the architecture of the enterprise – services for internal consumers (Ameller et al., 2015; Rojas et al., 2021). Thus, services are the linking element between the layers of the enterprise architecture.

It is necessary to expand the theoretical and methodological base in this direction, based on the principles of systems theory, business engineering, enterprise architecture, information management, project management, process management. The trend towards digital transformation of business and, in particular, industrial enterprises (the concept of Industry 4.0) requires an integrated vision of various aspects of enterprise management within a single model: business and technological processes, information systems and technologies, data, production infrastructure.

These are the challenges facing the research and practice community in developing approaches to effectively integrate management and IT technologies. In order to realize this task, it is important to provide a full range of approaches development and implementation:

- Identification of current requests for the development of existing approaches;
- formation of methodological foundations;
- documenting and discussing the results;
- training of specialists.

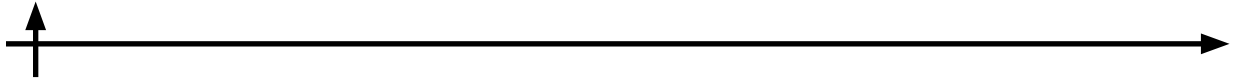
Peter the Great St. Petersburg Polytechnic University seems to be an appropriate platform for the development of approaches in the field of integration of operational, management and information and communication technologies, because it has the capacity to develop and implement approaches in all of the above aspects. For example, researchers at GSBE within the framework of their project activities actively use the architectural approach to design and re-engineer management systems of enterprises in various industries (healthcare, logistics, mining and processing industry, IT-consulting, retail). This activity includes testing in practice and sectoral adaptation of existing approaches, identifying requests for the development of theoretical and methodological framework, and developing reference (sectoral) models of architectural solutions. Development of theory and methodology of business engineering is carried out by researchers of the school in the course of implementation of grants and initiative research financed by various funds, while writing PhD and doctoral dissertations by research team members and under their supervision. There is the Dissertation Council on the basis of GSBE. It is specialized in the field of business-engineering theory development (within the scientific specialty 08.00.13 Mathematical and Instrumental Methods in Economics). GSBE implements a complex of bachelor's and master's programs for training specialists in the field of enterprise architecture, including both classical methods and models and the results obtained by the teachers in the framework of their project-research activities.



The Technoeconomics journal, created on the basis of GSBE, logically closes the range of activities to ensure professional communication and exchange of experience in the issues of technology integration. The magazine, among other things, aims to become a platform for publishing practical and theoretical achievements in the field of business engineering, enterprise architecture, digital solutions, control systems and their mathematical support. The journal will strive to become a significant platform for exchange of opinions, experience, topical research of the best scientists and specialists in the field of business engineering, enterprise architecture, business informatics, etc.

REFERENCES

- Alho P., Mattila J.** 2015. Service-oriented approach to fault tolerance in CPSs. *Journal of Systems and Software* 105, 1–17.
- Ameller D., Burgués X., Collell O., Costal D., Franch X., Papazoglou M.P.** 2015. Development of service-oriented architectures using model-driven development: A mapping study. *Information and Software Technology* 62, 42–66.
- El Bilali H., Allahyari M.S.** 2018. Transition towards sustainability in agriculture and food systems: Role of information and communication technologies. *Information Processing in Agriculture* 5, 456–464.
- Giachetti R.** 2016. *Design of enterprise systems: Theory, architecture, and methods*. CRC Press.
- Helfert M.** 2008. Business informatics: An engineering perspective on information systems. *Journal of Information Technology Education: Research* 7, 223–245.
- Hoogervorst J.A.** 2018. *Practicing Enterprise Governance and Enterprise Engineering*. Springer.
- Iyamu T., Shaanika I.** 2019. The use of activity theory to guide information systems research. *Education and Information Technologies* 24, 165–180.
- Janssen T.** 2015. *Enterprise Engineering: Sustained Improvement of Organizations*. Springer.
- Jaradat R., Adams F., Abutabenjeh S., Keating C.** 2017. The complementary perspective of system of systems in collaboration, integration, and logistics: a value-chain based paradigm of supply chain management. *Systems* 5, 50.
- Lankhorst M. (Ed.)** 2013. *Enterprise architecture at work: modelling, communication and analysis*, 3rd ed. ed, The enterprise engineering series. Springer, Heidelberg; New York.
- Lankhorst M.M.** 2004. Enterprise architecture modelling – the issue of integration. *Advanced Engineering Informatics* 18, 205–216.
- Mertens P., Chamoni P., Ehrenberg D., Griese J., Heinrich L.J., Kurbel K., Messina D.** 1999. *Studienführer Wirtschaftsinformatik: Fach, Studium, Universitäten, Perspektiven*. Springer.
- Österle H., Becker J., Frank U., Hess T., Karagiannis D., Krcmar H., Loos P., Mertens P., Oberweis A., Sinz E.J.** 2010. Memorandum zur gestaltungsorientierten Wirtschaftsinformatik. *Zeitschrift für betriebswirtschaftliche Forschung* 6, 664–672.
- Paul P., Aithal P., Bhuimali A.** 2018. Business informatics: with special reference to big data as an emerging area: a basic review. *International Journal on Recent Researches in Science, Engineering & Technology (IJRRSET)* 6, 21–29.
- Prokopenko O., Omelyanenko V.** 2018. Information and communication technologies support for the participation of universities in innovation networks (comparative study). *Innovative Marketing* 14, 17.
- Rabelo R.J., Noran O., Bernus P.** 2015. Towards the next generation service oriented enterprise architecture, in: 2015 IEEE 19th International Enterprise Distributed Object Computing Workshop. IEEE, pp. 91–100.
- Rojas H., Arias K.A., Renteria R.** 2021. Service-oriented architecture design for small and medium enterprises with infrastructure and cost optimization. *Procedia Computer Science* 179, 488–497.
- Röling N.** 2019. *The agricultural research-technology transfer interface: a knowledge systems perspective*. CRC Press.
- Saharuddin A., Wijaya T., Elihami E., Ibrahim I.** 2019. Literation of Education and Innovation Business Engineering Technology. *Jurnal Edukasi Nonformal* 1, 48–55.
- Zachman J.A.** 2003. *The zachman framework for enterprise architecture*. Primer for Enterprise Engineering and Manufacturing. [si]: Zachman International.



СПИСОК ИСТОЧНИКОВ

- Alho P., Mattila J.** 2015. Service-oriented approach to fault tolerance in CPSs. *Journal of Systems and Software* 105, 1–17.
- Ameller D., Burgués X., Collell O., Costal D., Franch X., Papazoglou M.P.** 2015. Development of service-oriented architectures using model-driven development: A mapping study. *Information and Software Technology* 62, 42–66.
- El Bilali H., Allahyari M.S.** 2018. Transition towards sustainability in agriculture and food systems: Role of information and communication technologies. *Information Processing in Agriculture* 5, 456–464.
- Giachetti R.** 2016. *Design of enterprise systems: Theory, architecture, and methods*. CRC Press.
- Helfert M.** 2008. Business informatics: An engineering perspective on information systems. *Journal of Information Technology Education: Research* 7, 223–245.
- Hoogervorst J.A.** 2018. *Practicing Enterprise Governance and Enterprise Engineering*. Springer.
- Iyamu T., Shaanika I.** 2019. The use of activity theory to guide information systems research. *Education and Information Technologies* 24, 165–180.
- Janssen T.** 2015. *Enterprise Engineering: Sustained Improvement of Organizations*. Springer.
- Jaradat R., Adams F., Abutabenjeh S., Keating C.** 2017. The complementary perspective of system of systems in collaboration, integration, and logistics: a value-chain based paradigm of supply chain management. *Systems* 5, 50.
- Lankhorst M. (Ed.)** 2013. *Enterprise architecture at work: modelling, communication and analysis*, 3rd ed. ed, The enterprise engineering series. Springer, Heidelberg; New York.
- Lankhorst M.M.** 2004. Enterprise architecture modelling – the issue of integration. *Advanced Engineering Informatics* 18, 205–216.
- Mertens P., Chamoni P., Ehrenberg D., Griese J., Heinrich L.J., Kurbel K., Messina D.** 1999. *Studienführer Wirtschaftsinformatik: Fach, Studium, Universitäten, Perspektiven*. Springer.
- Österle H., Becker J., Frank U., Hess T., Karagiannis D., Krcmar H., Loos P., Mertens P., Oberweis A., Sinz E.J.** 2010. Memorandum zur gestaltungsorientierten Wirtschaftsinformatik. *Zeitschrift für betriebswirtschaftliche Forschung* 6, 664–672.
- Paul P., Aithal P., Bhuimali A.** 2018. Business informatics: with special reference to big data as an emerging area: a basic review. *International Journal on Recent Researches in Science, Engineering & Technology (IJRRSET)* 6, 21–29.
- Prokopenko O., Omelyanenko V.** 2018. Information and communication technologies support for the participation of universities in innovation networks (comparative study). *Innovative Marketing* 14, 17.
- Rabelo R.J., Noran O., Bernus P.** 2015. Towards the next generation service oriented enterprise architecture, in: 2015 IEEE 19th International Enterprise Distributed Object Computing Workshop. IEEE, pp. 91–100.
- Rojas H., Arias K.A., Renteria R.** 2021. Service-oriented architecture design for small and medium enterprises with infrastructure and cost optimization. *Procedia Computer Science* 179, 488–497.
- Röling N.** 2019. *The agricultural research-technology transfer interface: a knowledge systems perspective*. CRC Press.
- Saharuddin A., Wijaya T., Elihami E., Ibrahim I.** 2019. Literation of Education and Innovation Business Engineering Technology. *Jurnal Edukasi Nonformal* 1, 48–55.
- Zachman J.A.** 2003. *The zachman framework for enterprise architecture*. Primer for Enterprise Engineering and Manufacturing. [si]: Zachman International.

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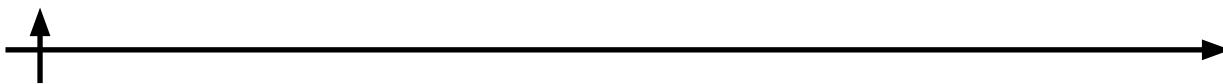
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Статья поступила в редакцию 29.11.2021; одобрена после рецензирования 15.12.2021; принята к публикации 27.12.2021.

The article was submitted 29.11.2021; approved after reviewing 15.12.2021; accepted for publication 27.12.2021.