

ABSTRACT
thesis of Bolshibayeva Aigerim
on the topic: «Development of methods and models Framework for
transformation of digital business-processes»,
submitted for the degree of Doctor of Philosophy (PhD) in the specialty
6D070400 – «Computer Engineering and Software»

The relevance of the research topic is due to the active introduction of information technologies in all spheres of activity of modern Kazakhstan. The task of accelerated innovative development and the formation of a digital economy is one of the priorities. The formation of a digital economy is a matter of national security and independence, competition of domestic companies.

The idea of digitalization or digital transformation of a society or economy has now become one of the intensively developing areas of scientific and technological progress, along which socio-economic systems will develop in the long term.

An analysis of the world practice of digitalization of the processes of the national economy shows that the digitalization of the economy is carried out based on digital platforms, with the help of which economic, social, and technological processes that form the ecosystem of the national economy can be integrated.

The term "digital economy" appeared in 1995, thanks to Don (Donald) Tapscott (one of the world's leading authorities in the field of business strategy), he defined it as follows: digital economy - an economy based on the dominant use of digital technologies; and the American programmer Nicholas Negroponte (founder of the Massachusetts Institute of Technology Media Laboratory) formulated its concept, in a condensed form it sounds like "the transition from processing atoms to processing bits", which means "from processing atoms that make up all substances, materials and objects, humanity is moving to the processing of data bits, from which all information and digital reality are built. New digital services are ultimately built from bits, just as traditional ones are built from atoms and molecules." In economically developed countries, it is customary not to change the classical definition given by scientists.

Scientists around the world use precisely the Tapscott definition when studying these categories. Over time (in 2001) Thomas Mesenburg identified three main components of this concept, in particular: supporting infrastructure (which includes hardware and software, telecommunications, networks, etc.); e-business (how a business is conducted, any processes that an organization conducts through computer networks); electronic commerce.

Let us define what we mean by the concept of "civilization". In this work, the term "digitalization" is understood as "automation".

Without dwelling on the semantic intricacies of these concepts, we will call this problem the general concept of “digitalization of the economy” or “digitalization of society”.

To conduct digitalization of a society or economy, it is necessary to start by defining the field of economics and in it the corresponding problem area of research based on the goals. To do this, you should analyze the entire national economy of the country.

It should be noted that in modern global conditions, logistics plays a key role in the industrial development of states. In several countries, including Kazakhstan, the government initially relied on the development of logistics as the main factor in stimulating industrial development. In the Republic of Kazakhstan, this tool can bring a significant economic effect for an industrial breakthrough:

- firstly, it is a stimulating logistics service for existing and new enterprises. These include the acceleration, simplification, and reduction of the cost of domestic transportation in the supply of raw materials to production, delivery of finished products to the consumer, transportation over long distances, to hard-to-reach areas.

- secondly, these are national expert services, i.e., logistics stimulating the attraction of transit through the territory of Kazakhstan.

- thirdly, logistics, contributing to the activation of investment processes in the country's economy, that is, external effects of logistics, when a foreign partner decides to implement investment projects in Kazakhstan thanks to a developed logistics system.

At the 25th plenary meeting of the Council of Foreign Investors, the First President of Kazakhstan announced the start of the project “Kazakhstan - New Silk Road”: “Kazakhstan must revive its historical role and become the largest business transit hub of the Central Asian region, a kind of bridge between Europe and Asia. This is the creation of a single complex of international-level hubs on the key transport corridors of Kazakhstan - trade and logistics, financial and business, innovation and technology and tourism”.

The governments of many countries are betting on the development of logistics, which is the main factor in stimulating economic development. In modern conditions, logistics is assigned a key role for the industrial development of the country, since all cargo transportation in Kazakhstan and goods delivered from Kazakhstan depend on the correct logistics schemes.

Especially important is the fact that an integral component of successful economic development is the implementation in practice of an internal component - the Logistic Map of Kazakhstan. This planning tool for the entire transport and logistics system makes it possible for many industrial enterprises on a long-term basis to make forecasts of income and expenses, implement a long-term marketing policy, and consider all positive factors financially. Its structure should be suitable both for the business as a whole and for individual companies and government agencies. An important external instrument should be the

implementation of the "Kazakhstan - New Silk Road" project, aimed at Kazakh transit. Kazakhstan here will have several advantages at once, the main of which are: delivery times, freezing of finances and time; the route, which will mainly pass through the territory of China, as well as the construction of a green corridor - the Trade and Transport Hub and an important factor - the historical route of the Silk Road.

All over the world, logistics itself is a very profitable segment. The global transport logistics market is estimated at 2.7 trillion US dollars, i.e., about 7% of world GDP. In developed countries, the share of transport logistics is somewhere around 13-14% of GDP. So, in Ireland this figure reaches 14.2%, in Singapore - 13.9%, Hong Kong - 13.7%, in Germany - 13%. This indicates that these countries are paying special attention to the development of this sector as one of the sources of national income. The share of logistics in Kazakhstan is approximately 8%.

It can be noted with confidence that the transit potential should be viewed as a point of economic growth for the country. To this end, it is necessary to increase the attractiveness and create the most modern efficient transport and logistics system in the CIS, improve transport and logistics operations in any type of transport, taking into account the provision of a wide range of services, offer competitive tariffs, further improve the corridors for transit cargo flows to on a permanent, linear basis, where the transit times, cost and systematic use of these corridors will be clearly defined, the organization and development of optimal conditions and infrastructure for incoming and outgoing cargo flows, followed by local distribution to final destinations. It should be noted that this is far from a complete list of tasks that need to be performed to maximize the use of the transit potential of Kazakhstan. If this is done, Kazakhstan will greatly benefit from the contribution of transport logistics to economic development.

Logistics consists of many processes, from the process of purchasing and delivering cargo to the warehouse, ending with the processes of delivering and delivering cargo to customers, as well as the implementation of a financial transaction (payment) for the cargo.

One of the important processes in the supply chain is the processes of accumulation and storage.

Solving the main tasks of warehouse logistics: choosing the type of warehouse; rational placement of goods in the warehouse; equipping with modern technological equipment; automation and computerization of warehouse management, accounting and other works; competent assurance of the safety of goods; personnel training; careful organization of accounting of costs, losses and efficiency of the warehouse process still remain a weak point in the work of most enterprises in almost every region of our country. Currently, the new warehouse network of enterprises is being formed in many respects spontaneously. When designing warehouses, choosing lifting and transporting equipment, calculating economic indicators and parameters of the technical equipment of warehouses,

as a rule, the logistics requirements for the organization and management of goods movement are not fully considered. This leads to the irrational use of scarce financial and material resources, both at the level of business organization and the economy. The lack of realistic practical recommendations for the use of optimization, rationalization, improvement of warehouse processes, operations, technologies at resource-supplying enterprises leads to the fact that warehouses often become a "restriction" in the construction of logistics management systems.

All these circumstances determine the relevance of the topic of the dissertation research aimed at developing guidelines for the modernization of warehouse business-processes.

For the correct and effective improvement and development of logistics activities, it is required to formulate tasks for the optimal performance of both general processes and special processes, as well as build an effective algorithm for their solution, considering the relationship between the task and the processes.

For all these stages to be performed (worked) optimally and smoothly, it is necessary to consider all the processes of warehouse activity in a comprehensive manner, covering all specialized processes that are part of the general business process.

Thus, the outlined circumstances determine the importance of the topic of the dissertation research in terms of the digital transformation of the business processes of the national economy its sections related to logistics processes.

The purpose of the dissertation work. Research the development of models and methods that ensure the digital transformation of business processes for the automation of logistics processes, the definition of algorithms and principles of operation, the definition of software development technologies for business processes.

The objectives of the study. According to this goal, the following scientific tasks have been identified, which must be solved in this work:

1. Research of existing methods of designing logistics business-processes.
2. Development of models and methods for digital transformation of business processes: methodology of forms of business processes and its automation.
3. Development of a meta-model of a business process.
4. Development of software and information support.
5. Experimental evaluation of the choice of a web service developer in the composition of services.

Object of study. Business and logistics processes.

Subject of study. Models and methods for the design of business-processes that improve performance and automation.

Research methods. To solve the problems defined in the dissertation research, the work uses: set theory, combinatorial optimization. Such research methods are applied as analysis of literary sources and documents to study the problem and determine the theoretical and methodological foundations of the

research; concretization, induction, and deduction of theoretical knowledge; abstraction, classification, and systematization of theoretical and experimental data on the research problem.

Scientific novelty.

1. Models and methods for designing business processes with observability and controllability properties.

2. Incremental-iterative methodology, which allows to reduce the objectives of the research, thereby allowing to highlight the subject area of research.

3. Optimization of the choice of a web service for different categories of goods, based on fuzzy logic algorithms.

4. The theory of building software for a business process automation system based on BPEL.

Provisions for Defense.

- Methods and models for the design of automated business processes, considering the special processes of the company.

- Algorithm for constructing a fuzzy composition.

- Application integration solution (considering data integration and building a fuzzy relationship algorithm for choosing a web service developer) for a logistics platform.

The practical significance of the work. The proposed methods and models for designing automated business processes will allow to achieve effective management and functioning of processes with minimal labor costs of resources (in particular: human and production). The software and methodological solution proposed in this study is universal, corresponds to the achievements of modern science and technology in the automation of business processes, the proposed design methods are customizable to the production and technological capabilities of the enterprise.

The developed methods have been tested in logistics companies (Dragon Systems LLP (Almaty) and BK Logistics (Almaty)), which is confirmed by acts on the implementation of the results of the dissertation work.

Personal contribution of the researcher. The researcher personally solved the problems of the dissertation work. A comprehensive methodology of business process forms and its automation has been developed. The architecture and program of the proposed platform have been developed.

The connection of the topic of the dissertation with the plans of research work. The dissertation work was carried out under the project No. BR05236517 under the program of targeted program financing of scientific research for 2018-2020 of the Ministry of Education and Science of the Republic of Kazakhstan, project leader, Doctor of Technical Sciences, Professor of the International Information Technologies University of Uskenbayeva R.K.

The volume and structure of the work. The thesis contains an introduction, 4 sections of the main content, a conclusion, a list of used literature

(66 sources) and 10 appendices, the total volume of work is 126 pages, 57 figures and 24 tables.

In the introduction, the relevance of the study was determined, and the problems associated with the topic were shown, the degree of scientific elaboration of the topic was studied, the object and subject of the study, the goal were established, the tasks were formulated, and the main provisions put forward for defense were given.

The first chapter defines the role of digital transformation in the economy of Kazakhstan as a whole, provides an incremental-iterative methodology that allows you to narrow the scope and problem of research using the multiplier effect, i.e., in which even a slight increase in investment in any industry causes an increase in investment and production in other related problem sectors. Also in this chapter, the basic concepts of dissertation research are given, an explanation is given in the equivalent use of the concepts of Framework and platform. The analysis and classification of digital platforms that exist now are carried out, and based on the analysis, it is proposed to build a platform based on a new concept or model of a business process. This model should ensure the generation of a business process model, and then, based on this business-process model, the generation of a business process automation system. The formulation of the research problem is given.

The second chapter describes the work on developing methods for designing deterministic processes. For this, an analysis of existing methods for modeling business processes was carried out. The technological and model foundations of business processes have been determined. A methodology for designing a deterministic process is presented, which consists of seven stages.

- Stage 1: designing the problem area by separating it from the company's activities;
- Stage 2: design of the power supply unit as it is, i.e. as "as-is";
- Stage 3: design, BP in the form as it should be, i.e. in the form of "to-be";
- Stage 4: design, extended power supply in the form of "to-be-EXT".
- Stage 5: designing a complete BP in the form of a set of classes of object-oriented representation, i.e. as "to-be-OOV";
- Stage 6: designing a component-service representation of a BP in the form of "to-be-WS" - representing a BP in the form of a set of service classes;
- Stage 7: designing a component-service representation of a BP into a complete business process in the form of "to-be-AS" - a BP with an automation system.

A business process model for design purpose consists of concatenating life cycle models of the design process of a complete business process.

Hence, the step-by-step general model of the results of the stages of designing a business process is as follows:

$$M = \langle MC, M_{pr}, M_{AS-IS}, M_{TO-BE}, M_{TO-BE-EXT}, M_{TO-BE-OOV}, M_{TO-BE-WS}, M_{TO-BE-AS} \rangle$$

A business process includes many objects or items, many special processes, items and means of labor, and also includes methodologies and technologies and responsible executors for the execution of the business process. Thus, the business process has a complex structure and composition, i.e. architecture and complex components of this architecture.

Therefore, the presence of a model allows you to streamline and speed up the process of building both the components of the business process and, in general, the business process itself, the creation of which is planned.

The methodology describes each stage, all stages depend on each other, since each subsequent stage is built on the model of the previous stage.

The application of methods for constructing automatic control systems to the design of an observable and controlled business process is also described.

In the third chapter, the mechanisms of integration at the design stage are considered, since the design of a business process is the result of the design of all their components and their integration. Integration is considered at several levels. The need for integration arises both at the level of data and software modules (within models and intermodular relations) and at the level of the logistics system as a whole, i.e. to harmonize the robots of the logistics system with other systems, for example, ERP systems, CPM systems, enterprise PLM systems, etc. This factor requires that the system be integration-oriented or integration-adapted, i.e. adapted to integration processes.

In the fourth chapter, based on the proposed theories and using the results obtained, the platform architecture is substantiated and built. It also describes the theory of building software for a business process automation system based on BPEL and an algorithm for constructing a fuzzy composition, an integration solution for applications for a logistics system is proposed.

All theoretical aspects described in the previous chapters find their practical implementation in this chapter. The integrated logistics platform consists of three local logistics platforms: digital warehouse platform, digital shipping platform, online store platform. This chapter describes in detail the architecture and the main components of the developed integrated platform using the composition of web services.

In the conclusion, the main results and conclusions of the dissertation research are presented.

Reliability level and testing results. The validity and reliability of the study correspond to the justified responsibilities of the task, the analysis of the criteria and the state of research in this area, many experiments carried out and their successful implementation in practice. The results of the dissertation were discussed and reported at the following scientific and methodological conferences:

1. International Conference on Control, Automation and Systems - ICCAS'18 (Korea, 2018)

2. International Conference on Control, Automation and Systems - ICCAS'19 (Korea, 2019)

3.2 reports at WCGO 2019, World Congress on Global Optimization, (Metz, France, 2019)

4. The 17th International Conference on Mobile Systems and Pervasive Computing (Leuven, Belgium, 2020)

On the topic of the dissertation, 9 articles were published and 2 copyright certificates was obtained:

1. Bolshibayeva A.K., Uskenbayeva R.K., Kuandykov A.A., Rakhmetulayeva S.B., Astaubayeva G.N. Development of business process design methods // Journal of Theoretical and Applied Information Technology. – 2021. – Vol.99, №10. – P.2344-2358

2. Uskenbayeva R.K., Kuandykov A.A., Rakhmetulayeva S.B., Bolshibayeva A.K. An algorithm for creating an automated system based on platform of business process // Procedia Computer Science. – 2020. – Vol.175. – P.253-260

3. Uskenbayeva R.K., Rakhmetulayeva S.B., Bolshibayeva A.K. Managing Business Process Based on the Tonality of the Output Information // Advances in Intelligent Systems and Computing. – 2020. - №991. – P.882-890

4. Uskenbayeva R.K., Kuandykov A.A., Rakhmetulayeva S.B., Bolshibayeva A.K. Research of the Relationship Between Business Processes in Production and Logistics Based on Local Models // Advances in Intelligent Systems and Computing. – 2020. - №991. – P.861-870

5. Uskenbayeva R.K., Kuandykov A.A., Rakhmetulayeva S.B., Bolshibayeva A.K. Properties of platforms for the transformation and automation of business processes // Матер.международ.науч.конф. «International Conference on Control, Automation and Systems». – Korea, 2019-October, p. 29–33, 8971550

6. Uskenbayeva R.K., Kuandykov A.A., Rakhmetulayeva S.B., Bolshibayeva A.K. Basics of creating platforms for automation of business processes of logistics // Матер.международ.науч.конф. «International Conference on Control, Automation and Systems». – Korea, 2018-October, p. 1265–1271, 8571757

7. Uskenbayeva R.K., Bolshibayeva A.K., Rakhmetulayeva S.B. Integration of is in the design of integrated logistics platform// Вестник КазНУ. Серия “Математика, механика, информатика”, No 2 (110) 2021, стр.97-112

8. Uskenbayeva R.K., Kuandykov A.A., Bolshibayeva A.K. Ensuring observability and control of business processes in the existing logistics system in Kazakhstan// Bulletin of the National Engineering Academy of the Republic of Kazakhstan, No 3 (81) 2021

9. Uskenbayeva R.K., Bolshibayeva A.K., Rakhmetulayeva S.B. A model of organizing the components of a business process into a complex business process for subsequent automation. Vestnik KazNPU named Abay. Physics and

Mathematics Series, No 3 (75) 2021

10. A.S. 13949 "Mobile application of the electronic trading platform and transportation of goods" Mobile Isker Logistics // R.K.Uskenbaeva, A.A. Kuandykov, S. B. Rakhmetulaeva, E. N. Karabaliev, T. K. Adibek, A. K. Bolshibaeva; publ. 12/20/2020. - 2 p.

11. A.S. 13969 "Isker Warehouse Smart Warehouse System" // RK Uskenbaeva, AA Kuandykov, R. Zh. Satybaldieva, AN Moldagulova, Ə.S. Əlipbekov, A.K. Bolshibaeva; publ. 12/21/2020. - 2 p.