

Situational Digitalization of the Population Activities

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Abstracts — A review presents the concept basics for situational digitalization of the population activities considered as an aggregate of educational, production and other kinds of activity. Situational digitalization is studied as a means of stage-by-stage organizational and technological improvement of the object through planned transitions from the starting situation to the target one. The situations are represented by formalized descriptions of the predefined set of “State spaces” (defense, economic, etc.), which characterize the country potential. The object is monitored on the basis of portraits of the achieved situations. Information technologies, based on the situational digitalization methodology, are implemented in the human-machine environment for problem solving (s-environment), which serves as an infrastructural base of online services (banking, logistics, etc.). The definitions of public administration system, country's potential, the types and the portraits of situations, etc. are updated.

Key words — digital economy; situational digitalization; human-machine environment for problem solving; population activities; public administration system; country's potential.

I. INTRODUCTION

Computer-aided design of machines (started in 1960s) [1-2], software and other things has become the inspiring example of efficient use of computers as people assistants. To date of intensive development of cloud computing and online services for different purposes (planning, education, etc.) [3-7], the attention of IT researchers and developers is focused on idea of combined service-based automation of various activities. Since the mid-1990s, the importance of effective implementation of that idea [named as “digital economy”] has been steadily escalating and integrating with the of corporations and countries competitiveness [8-10]. The USA give special attention to knowledge control and design of innovative products with good market perspective; Germany – to embedded systems and smart factories; Japan – to cyberphysical systems and progressive robotics; the countries with strong agriculture – to technologies of precision farming.

Internet of things (IoT) changes the environment of economic activity [11]. The IoT development produces new opportunities for rising the efficiency of economic activity, but also new problems [12]. The 3D printing technology has high potential for changing everything - from everyday needs to global economy [13-14]. The social networks are increasing their impact on the economical behavior of buyers and manufacturers [15]. The role of information media is growing [16]. Farms become similar to factories: they tightly control operations for producing reliable products which have to be maximal immune to the nature vagaries [17-20]. The concept of Climate-Smart Agriculture is oriented to the need of efficient strategy to manage agriculture and food systems facing climate change [21].

The growing use of information technologies in different kinds of activities supposes the development of methodological support for digitalization projects.

The G20 community has determined its position on the digital economy in 2016 [22]. In 2017, Russia has approved the state program “Digital Economy of the Russian Federation” [23].

The text fragments markup. To markup definitions, examples and remarks, the following means of the TSM-complex language (TSM: textual symbolic modeling, developed for the formalized description of textual models¹) are used:

- <description fragment> □ ≈ statement (definition, axiom, etc.) (hereinafter, the symbol ≈ replaces the word “means”);
- <description fragment> ○ ≈ example;
- ◇ <description fragment> ◇ ≈ remark.

The first appearances of the concepts names and the most important description fragments are given in italics.

The presented results. The article represents several basic concepts developed during performance of research work “Modeling of social, economic and environmental processes” (0063-2016-0005, the state task of FANO of Russia for the Federal research center “Informatics and control” of the Russian Academy of Sciences). The paper content is oriented primarily to people involved in the methodological support of IT development for the digital economy [23].

□ *Situational digitalization of the population activities* (hereinafter “digitalization” for brevity) is considered as a complex of organizational and technological means of improvement of the object by means of the planned transitions *from starting situation to the target one*. The situations are described by the formalized specification of economic, military, scientific, educational and other spaces of conditions which form the *country potential* [24]. □

The infrastructural basis of digitalization is the *human-machine environment for problem solving (s-environment)*, which includes computer and robotic devices and networks, online services (where the important part is *resource planning services* [25]) and other kinds of software. At each stage of enhancement of the potential, a set of connected digitalization projects is performed for public administration, economic, military, scientific, educational and other activities.

The country potential, the economic mechanism, the

¹ Ilyin, V. D. 2018. Simvol'noe modelirovanie [Symbolic modeling] // Bol'shaya rossiyskaya entsiklopediya [Great Russian Encyclopedia]. Available at: http://dev.bigenc.ru/technology_and_technique/text/4010980 (accessed April 15, 2021).

technology of commodity-money circulation in the *normalized economic mechanism (NEM)* [26], and other entities are investigated in the framework of scientific project devoted to creation of the NEM digitalization methodology and implementation of *the resource planning online services* [25].

The conceptual basis of digitalization is considered as contribution to the methodological support of implementation of the "*Digital Economy of the Russian Federation*" program [23]. This basis was firstly described as *the methodology of situational informatization of public administration in Russia* [24].

II. DIGITALIZATION OF PUBLIC ADMINISTRATION AND ECONOMIC ACTIVITY

The population activities are realized in the processes of *status rivalry* between individuals and between legal entities [24].

□ *The purpose of public administration* is protection and enhancement of the *country potential* by means of legal regulation of the status rivalry processes. □

◇ Changes of the country potential allow evaluating a state of the object of public administration. The priority list of indicators of the country potential and their interpretation (including ways of assessing and stimulating the changes) form the basis of planning the population activities management. ◇

□ **The country potential** is determined by characteristics of the population, the natural habitat and the systems of life organization and support.

Characteristics of the population (the symbol Δ means poor controllability or impossibility of control by means of the public administration; the symbol \circ means potential controllability) are:

Δ the population number, its gender and age structure, fertility and mortality, density;

Δ level of the population health;

Δ the culture level that characterizes the population respect to the gene pools of the family, the nation and the biosphere; attitude towards the work, education, creation, towards traditions which strengthen the family and the nation;

Δ an inventiveness level (determined by amount and significance of discoveries, inventions, rationalizations; amount and level of the invented tools and technologies);

\circ professional and qualification level of the population.

Characteristics of the natural habitat:

Δ size and location of the country; flora and fauna; relief, climate, sensitivity to natural disasters;

\circ reserve of poor and technical water;

\circ size and fertility of agricultural lands;

Δ minerals (especially sources of raw materials for producing energy and other necessary products);

Δ rivers, lakes and seas (first of all, the suitability for fishery and navigation).

Systems of life organization and support, including the public administration system and the economic mechanism, are defined by:

\circ level of meeting demand for water, food, clothing, housing, energy; of health and education care; social

security;

\circ level of meeting demand for industrial raw materials;

\circ level of effectiveness of economic mechanism;

\circ level of environment protection;

\circ level of information technologies support [the prevalence and quality of electronic services available to population in educational, scientific, industrial and other activities which are related to constructing and using the models of concept systems and knowledge systems];

\circ level of communications, including transport network;

\circ level of protection of the population and environment from epidemics, natural and man-made disasters;

\circ volume of the created national wealth:

– quantity and quality of water, food and energy supply systems;

– agricultural fund of seeds;

– reserves of precious minerals and metals;

– national (originally described in the state language) arsenal of knowledge systems;

– a housing quantity and quality;

– quantity and quality of educational, scientific, health, defense, industrial, agricultural, cultural facilities;

– renewable stocks of necessary facilities of life support;

\circ level of legislation, determined by consist and quality of laws (the law quality is determined by compliance to a part of status rivalry processes which is regulated by this law);

\circ level of law implementation;

\circ level of defense ability;

\circ level of national security (willingness to detect and suppress encroachments on freedom and rights of citizens, the country potential and state institutions). □

A number of components of the country potential have a difficultly predictable change in time. This fact primarily applies to the characteristics of the population and habitat. The reasons for the difficult predictability are substantial nonstationarity, weak observability and difficultly estimated inertia.

◇ The country potential changes mainly as a result of the population economic activities. Key component of the country potential is the able-bodied population. Prosperity and security of the country depend on the population diligence, willingness to defend the country, inventiveness; on the population attitude towards the family and the state (including resources). It is necessary to have operational information on the changes of the controlled components of the potential for efficient state control which should direct the population activities to the development of the country potential. ◇

◇ Inconsistency between the population activities and the tasks of protecting and developing the country potential leads to one of the following outcomes:

– the necessary changes are planned and implemented in the systems of organization and control of population activities and in the rules of participants behavior (citizens, corporations, state authorities);

– no changes are made, and the country potential is steadily degrades.

The second outcome makes the final disappearance of such state system highly probable (in historical perspective). ◊

Proposals for the improvement of IT services for public administration, economic mechanism and other systems of population activities, their reasoning and ways of implementation are reflected in *the methodology of situational digitalization of the population activities*, which includes:

- set of the object improvement tasks (representing the goal of the methodology);
- the *concept systems for formalization, targeting and implementation*;
- formulations and methods for solving problems that determine the relationship between the concepts.

□ **Model of the concept system** is represented by the pair $\{mem, rel(mem)\}$, where *mem* is the set of concepts, and *rel(mem)* is the set of relations defined on *mem*.

Definition of the concept system is presented in the form of its model description, supplemented by description of the application area.

Description of application area of the model includes

- description of the correspondent type (for whom the model is intended);
- description of the classes of problems, in the study of which the model can be useful;
- description of the research stage, where the use of the model is appropriate.

Representation of relations between concepts in the form of solvable problems is the necessary condition for constructing quantitative models of the concept systems in the methodology. □

○ For robotic crop farming, robots need to autonomously navigate their environment and perform actions at set locations (planting a seed, spraying a pesticide, etc.). In the case of outdoor farming, the robots work by receiving a plan with a set of locations to visit on the field. When the robot trajectories are known, the robot can use GPS or GLONASS positioning and a closed-loop control to make sure it remains on track. When the task is to follow an unknown trajectory, vision is used to allow the robot to find its way. Robots are wirelessly connected to a central operator to both receive updated instructions regarding the mission, and report status and data [27]. The set *mem* of the concept system "robotic crop farming" include the concepts "planting a seed", "watering", "trajectory", etc. The family of relations *rel(mem)* is represented by the problems of optimal seed allocation, optimal watering, etc. ○

□ A problem is considered as the tetrad $\{Formul, Rulsys, Alg, Prog\}$, where *Formul* is the problem statement (including the concepts and relations between them); *Rulsys* – a set of systems of mandatory and orienting rules for solving the problem; *Alg* is the union of sets of algorithms, where each set corresponds to some system from *Rulsys*; *Prog* is the union of sets of software programs, where each set corresponds to one algorithm.

A description of applicability is given for each element of *Rulsys*, *Alg* and *Prog*. Descriptions of applicability of the *Rulsys* elements include the specifications of the solver type

(stand-alone computer, network computer cooperation, human-computer complex, etc.); the requirements for information security, etc. Descriptions of the *Alg* elements applicability include specifications of the admissible modes of the solver work (interactive local, automatic local, automatic distributed, etc.), requirements for the result, etc. Descriptions of the programs applicability include specifications of implementation languages, operating systems, etc. □

The key problems are forming *the situation portraits* (on the basis of monitoring "*the state spaces*"), analysis of the situations, development of the resource-based controlling actions, decision-making and control over decisions execution. The controlling actions are to be designed so that it is possible to transfer from *the starting situation* to *the target situation* (or its defined neighborhood) under the given resource constraints.

□ **State authorities** – organizational and technical complexes developed

- for creating and protecting the legal space;
- for regulating a part of the competitive population activities (status rivalry) defined by law;
- for planning protection and development of the country potential and organizing the implementation of the developed plans;
- for planning and implementing interaction with other countries which is directed to increasing the country potential.

At each stage the purpose of state regulation of the population activities is represented by the set of tasks for planning the development of the country potential (represented by the specifications of its starting and target states).

Regulation has to be carried out on the following basis. For successful protection and development of the country potential it is necessary that

- the educational institutions of the country teach the required number of specialists, primarily for the production of vital goods (food, clothing, housing, energy; educational, health, military and other services) and protection of the country potential;
- educational and economic systems are on time adapted to the needs of the vital goods production and development of the country potential. □

□ **Model of the public administration object** is a formalized representation of the status rivalry processes which impact the country potential and are regulated by legal means.

The public administration system, as an object of situational digitalization, is a stochastic non-stationary organizational and technical complex which is characterized by:

- complex human-machine environment for defined purpose, where the rules for the application of electronic services are strictly regulated;
- high interdependence of authorities and the object of control [the object has at least information impact on the authorities, influencing their behavior];
- low identifiability. □

□ **State situation** is a fragment of the states of public administration system, represented by a temporal series of portraits of the situation which are intended for analysis of and design of controlling impacts. *Target situation* is the situation planned to be created as a result of the controlling impact. *Starting situation* is the situation, in relation to which the impact is being developed. *Achieved situation* is the situation that has actually obtained as a result of the controlling impact. □

□ **Portrait of the situation** is a formalized description of *spaces of the controlled object states*. It contains data characterizing the basic parameters of the object condition, available variants of the controlling impact and description of the resources which are necessary to implement that variants. Portrait of the situation is formed in accordance with especial system of rules. The input of the system is data on the spaces of states, data on available types of controlling impact and available necessary resources. The output is data on the *situation type, prototypes of the controlling impacts* and evaluation of the resources for each type of impacts. □

◇ The public administration system, as an object of situational digitalization, is represented by the model named *the complex of the state spaces*. The state spaces are the set of representations (from different aspects) of the object state, defined by experts. ◇

□ **A State space** is defined by:

- the name (for example, "Economic state space");
- the types of violations with criticality evaluation;
- the admissible controlling impacts;
- the resources which are necessary to implement the impacts (*the providing resources*);
- the systems of mandatory and orienting rules, defining a correspondence between the violations and the controlling impacts, and between the impacts and the providing resources;
- the rules of creating the providing resources. □

The processes of development and execution of controlling impacts are represented by complexes of main and auxiliary tasks. The main tasks are the constructing and analyzing the portraits of situations, development of resource-supported impacts, planning the implementation of impacts and managing their execution. Interaction with the data sources, documenting messages, processing and archiving documents and similar tasks are auxiliary.

□ **The state impact project** is a documented plan for achieving the target state situation. *Achieving the target situation* is a step-by-step process that ends when portraits of the achieved and target situations are recognized as close enough. A comparative analysis of the difference between portraits of the target situation and the starting one produces the data for planning the process of achieving the target situation. State impacts are implemented using the information, economic, administrative, judicial, enforcement means. The choice of means is to be performed by experts using databases of available means and prototypes of impacts. The necessary set of resources depends on the

chosen composition of means. □

Digitalization of the state impact projects requires methodological support for

- development and implementation of the database of state impact prototypes;
- development and implementation of the database of resource support prototypes;
- development and implementation of the database of *state spaces* specifications;
- development and implementation of the technology for interaction with sources of the messages;
- forming and analysis of portraits of the state situations, resource-supported projects of state impacts;
- interaction with decision makers.

◇ Digitalization of economic activity is inseparably linked with digitalization of public administration and other types of the population activities. It is considered as a means of a gradual transition from the current economic mechanism to the normalized one [26]. ◇

III. CONCLUDING REMARKS

The purpose of *situational digitalization of the population activities* is the organizational and technological improvement of the object for increasing the country potential, increasing the competitiveness of citizens, educational and scientific institutions, manufacturing enterprises and other organizations.

The stage-by-stage situational digitalization presupposes interconnected improvement of the electronic services of economic mechanism, public authorities and other systems of population activities.

Characteristics of the components of country potential are used in forming the indicators of the effectiveness of the population activity.

The components of population activity as an object of situational digitalization are represented by spaces of conditions called the *state spaces*.

Portraits of *starting, target* and *achieved* situations are represented by the specifications of the state spaces, which contain data characterizing the essential parameters of the object state, available variants of controlling impacts and the resources necessary to realize the impacts.

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