

Problems of analytical substantiation of digital transformation of economic entities including their heterogeneity

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Abstract — This article justifies that the dynamism of the business context provides a high degree of diversity of forms of its functioning, promotes competition in the sphere of development of business models. The study shows that the previous methods of comparative analysis of economical entities lose their practical significance. The reason for this is that the necessary assumption of homogeneity of the business environment for the application of such methods becomes a serious obstacle. Therefore, the study defines analytical approaches and methods for assessing the effectiveness of the implementation of digital solutions, including the heterogeneity of the set of economic entities. So, to take into account the heterogeneity of economic entities, it is proposed to conduct a multiple benchmarking. This approach reflects the current orientation of the development of competition of various business models, allowing alternative options for the functioning of economic entities at the reference level. The study identifies the main stages of the methodology for analyzing the effectiveness of digital solutions based on the adaptation of the mechanism of shell data analysis.

Keywords — *Digital solutions, sustainability, stakeholders, benchmarking*

I. INTRODUCTION

The innovative course of evolvement of the modern Russian economy is the basis of the most important concepts and programs of the country's top officials for many years. A special position among possible innovative solutions is occupied by those aimed at a significant change in the business in general and the multiplication of individual elements of its intellectual capital [1]. Among these solutions are digital problems which are acute issues for each economic entity. Innovations caused by the digital transformation of the economy and society require a deep revision of the strategy, new business models, and affect the interests of almost all groups of stakeholders. The scale of changes in companies as a result of the introduction of digital solutions is determined not only directly by the object of innovation, but also the needs for the implementation of other solutions related to

digitalization. Generally, digital solutions are one of the elements of complex business change programs. The most viable phenomenon in the modern innovative development of economic entities are programs of company transition to digital functioning, in which in addition to the digital solutions, the possible solutions to change the organization of work, the composition and quality of management processes, skill shortages etc.

Evaluation of the effectiveness of digital solutions aimed at comprehensive business change should be based on the analysis of the resources involved for their development and integration, as well as the expected increase in value for key stakeholder groups. It should be noted that the composition and requirements of key stakeholder groups vary from one context to another, which should affect the assessment of the effectiveness of decisions. More recently, there has been a long persistence of political, economic, social and other conditions for the functioning and development of economic entities, which has provided stable conditions for managerial decisions. In few last years, the situation in the business environment has changed significantly. The volatility of the business environment is continuously increasing, and it is becoming less possible to eliminate changes in the conditions of the organization's functioning without threatening the economic security of the organization. The development of modern technologies is accelerating and is not going to slow down, business requirements are growing, and the range of business stakeholders is expanding [2]. All this are prerequisites for the formation of effective methods of analysis of innovative activity of the organization, which allows providing the necessary potential for the successful work of the organization in a rapidly changing environment [3]. Modern business is forced to operate in a specific condition where competition is increasingly expanding its scales both by strengthening the requirements of customers and by expanding the range of stakeholders whose requirements must be taken into account and fulfilled. According to the concept of sustainable development, organizations should strive to increase financial, and also social and environmental capital. The assessment of the effectiveness of digital solutions should take into account not

only financial benefits, but also other implications for the sustainability of the economic entity. A special role in the scientific base development of analytical support for effective digital transformation of business is the change management theory, the stakeholder concept [4]. The processes of initiating and implementing digital solutions must be systematic. Qualitative analysis of efficiency will allow not only to effectively implement digital solutions, but also to ensure initiation of business changes in time, to choose the most optimal comprehensive digitization programs. Therefore, it is necessary to develop methodological base and tools, practical development of new tasks of control and analysis, which are due to the need for successful digital transformation of the organization.

II. MATERIALS AND METHODS (MODEL)

This study begins with an assessment a feature of the context of the functioning and development of the modern economic entity as its growing dynamism. It is further proved that the dynamism of the context provides a high degree diversity of forms of functioning, including the most perfect. This contributes to the penetration of competition in the development of business models of economic entities. All this becomes an obvious argument that the use of previous analytical approaches and methods to assess the effectiveness of such modern innovations as digital solutions does not meet the new modern conditions. In particular, previous methods of comparative analysis of a set of economic entities face with problems in ensuring their homogeneity. Therefore, this study aims to identify analytical approaches and methods to assess the effectiveness of the implementation of digital solutions, taking into account the heterogeneity of economic entities. A special role in comparative analysis is played by the assessment of the most optimal states of functioning of economic entities in a certain context. All this leads to the conclusion that the methodology of reference analysis developed by the authors of the study can be a solution to these problems. So, to take into account the heterogeneity of economic entities, it is proposed to conduct a multiple benchmarking. The study identifies the main stages of the methodology for analyzing the effectiveness of digital solutions based on the adaptation of the mechanism of shell data analysis.

III. RESULTS AND DISCUSSION

Managing an organization focused on meeting the unstable requirements of key stakeholder groups requires a significant rethinking and updating of analytical tools. The dynamism of the context of the economic entity functioning, when the requirements of stakeholders and their perception of value change, affects the change in the importance of private performance characteristics, their criterion of business value. Intense digitalization of modern society and economy has increased the dynamism of the context of the functioning of organizations to such an extent that it has become easy to notice how the metric of business values is changing. This is evident when, more recently, some digital solutions of unique value are becoming a widespread practice today. In such cases, there is a serious need for the company to comply with

competitive functioning, which is possible only after the introduction of a digital solution, which has become widely popular in the practice of relations between organizations and their stakeholders. In this case, the main task for the basis for the implementation of the digital solution will not be to lose the occupied positions, but to stand on the previous ones. Stakeholders understand that if an organization does not have a comfortable digital means of interaction, they can get it from other competing organizations. Therefore, this level of requirements involves the analysis of risks of untimely digitalization of the organization and loss of loyalty of stakeholders. In this situation it is necessary to use the tools of analysis of the organization's security, its resistance to factors that reduce the digital level. Here it is necessary to use the tools of analysis of the organization's security, its resistance to factors that reduce the digital level. The effectiveness of these digital solutions will be to minimize the costs of their implementation. In order to qualitatively assess the change in the level of compliance with the requirements of stakeholders of an economic entity as a result of the introduction of digital solutions, it is necessary to develop analytical approaches aimed at solving new management problems. According to the results of our research, one of these approaches is to develop analytical tools to determine the parameters of the most preferred, "ideal" functioning of the company in these specific conditions of the business environment. We propose to call the most preferable state of the company's functioning the ideal one. The most important role of benchmarking is to provide management decisions on business change with a system for measuring the target indicators for meeting the requirements of key stakeholders, assessing on this basis the reserves for their improvement and justifying corrections and innovative projects for the implementation of the identified reserves.

Analysis of the effectiveness of digital solutions is proposed to begin with the study of the composition and requirements of key stakeholders. Assessment of the level of their implementation will identify the problems to be solved through digitalization projects. To initiate the implementation of digital solutions, it is necessary to ensure the understanding that there is a need for the implementation to innovative business improvement programs. Taking into account the context of business functioning, first of all, involves the study of the composition and requirements of stakeholders. This allows you to subsequently determine the gap between the actual state of the requirements from the target. In our research we prove the need to identify the reference state of the organization, which reflects the most preferred level of compliance with the requirements of stakeholders. This allows you to determine which targets will be set in your organization.

To implement the practice of benchmarking based on the comparison the values of the indicators of many organizations: competitors and organizations-leaders, and the use of the data for the strategic development of a particular organization, it is necessary to take into account the holistic development and the relationship of the values of indicators. The main difficulty in choosing a tool for determining the standard, which would take into account the systematic connection of the selected indicators and their values. Moreover, such large-scale

changes expand the composition and content of the requirements of stakeholders. Therefore, when evaluating the effectiveness of strategic innovations, it is necessary to take into account their multi-purpose meaning and the variety of effects obtained. The organization's focus on maximizing the implementation of social, environmental and economic requirements of various stakeholders requires the solution of complex analytical tasks. This is a problem, for example, as a low-comparable metric of social, environmental and financial consequences [5]. Therefore, it is necessary to conduct further research to develop approaches and practical tools for a more informed synthesis of the results of improving the sustainability of the organization [6].

The identification of the reference state is associated with the study of variations in the implementation of the requirements of stakeholders by a variety of economic entities. However, a number of internal and external factors prevent direct comparative analysis of the characteristics of different economic entities. For such analysis, it is necessary to have the admission of homogeneity, which allows justifying the hypothesis of the existence of a single reference state for all compared economic entities. This approach was acceptable some time ago. However, the speed of changes in modern society, the expansion of the composition of key stakeholders and their requirements indicate the growing problem of disparity of economic entities, the strengthening of the role of individual characteristics and the need to consider their heterogeneity. Therefore, the traditional taxonomic approach of standard assessment requires an alternative, according to which many economic entities will be determined by a set of standards.

Heterogeneity of the set of compared economic entities acts as a generalizing prerequisite for the application of a set of standards. Heterogeneity of the set of compared economic entities acts as a generalizing prerequisite for the application of a set of standards [7]. Heterogeneity is that economic entities can implement different strategies and business models. At the same time, the highest overall level of compliance with the requirements of stakeholders, corresponding to the reference level, can be achieved by several existing and potential business models. In contrast to heterogeneity, homogeneity implies the application of maximally similar business models by economic entities that have different levels, degrees and stages of implementation of these business models. In this case, for a specific external context, you can define the most ideal implementation of the business model and define a sample. The analytical task of determining the standard is very similar to the definition of an integral indicator or rating number of traditional economic analysis. The problem of determining the set of standards in a heterogeneous set of economic entities has not been previously formulated, and, as a consequence, the methods of its solution are not defined. New conditions for the functioning of modern economic entities pose to analytical science the task of forming and developing approaches, methods, techniques that can scientifically determine the composition of standards in the aggregate of economic entities. For the reasonable allocation of standards we have to use some principals:

- Standards should take into account the specific context of the functioning of the economic entity;
- Standards provide an opportunity for economic entities to apply various development strategies and business models;
- Stakeholder requirements should be reasonably limited both from below and from above, i.e. their minimum and maximum levels should be defined;
- The relationship between stakeholder requirements needs to be taken into account;
- It is necessary to consider the limited internal capacity of the economic entity to meet the diverse requirements of stakeholders;
- the definition of standards is possible on the basis of the application of mathematical models in the case of providing solutions to the problem of integrated assessment of compliance with the key stakeholder's requirements;
- the set of economic entities should have a sufficient number to identify not only the standards due to the factors of the external context, but also to determine the composition of relevant to a particular economic entity standards with its internal potential. Such relevant standards make it possible to determine the approximation of the most preferable state for an economic entity.
- We have to ensure interactivity in the models used for benchmarking in order to enable key stakeholder groups to define benchmarks on the basis of their own subjective preferences and trade-offs between the interests of other stakeholders.

Such a set of principles for determining the standard in a heterogeneous set of economic entities significantly limits the choice of analytical tools that characterize their functioning and development.

The method of shell data analysis for complex systems [8] is based on the definition of the region of non-dominated States, in other words, "Pareto optimum". This approach meets the condition of heterogeneity, as each non-dominant state reflects the highest level of compliance with the requirements of stakeholders in a particular context, for a particular development strategy and business model functioning. It is obvious that each non-dominant state is either the reference state or the closest to the reference state. This assumes the development and solution of many problems of linear-fractional programming according to a specific algorithm. The number of tasks coincides with the number of compared economic entities, as each of them represents a specific alternative strategy or business model. For each alternative, the optimal state is determined, which together forms the Edgeworth-Pareto shell or, in the terminology of the shell data analysis technique, the effective hyper-surface. In this regard, the complex efficiency of the investigated object j_0 , reflecting the degree of compliance with the requirements of stakeholders, can be obtained as a solution to the following problem:

Maximize the efficiency of object state j_0 when the efficiency of other objects is ≤ 1 . As a result, we obtain a nonlinear mathematical programming problem [9], which is called the M1 model by the authors. The solution of the obtained set of optimization problems allows us to identify several economic entities with optimal in this context, the values of indicators that reflect the implementation of the requirements of stakeholders. Such economic entities determine the composition of the reference group.

Each organization determines the most appropriate reference state to determine the target values of indicators based on its own strategic vision and business model [10]. At the same time, it is very likely that there is no actually existing reference state that would strictly correspond to the ratio of the values of the indicators of the organization in question. In this case, it is necessary to determine the standards that are closest to this in their strategic vision or business model. The standards thus defined are called the relevant reference group.

The main stages of the methodology of benchmarking in the heterogeneity of economic actors should be saturated with the completeness of the conclusions in order to return to them only at the final stage. We propose the following basic steps:

Step 1. Development of a system of indicators reflecting the complex requirements of key stakeholder groups. Thus it is necessary to allocate those indicators which values should be increased (reduced) to carry them to outputs (inputs) in M1 model.

Step 2. The composition of the reference group is determined by calculating the M1 model.

Step 3. Analysis of the context of the economic entity. The analysis is based on the results of M1 model estimates, which are expressed in a set of values of relative efficiency h_0 .

Step 4. Based on the analysis of the strategy and business model of the economic entity, the analyst determines the managed and unmanaged parameters, the minimum permissible weights of the parameters, as well as the preferred orientation of management: minimize inputs or maximize outputs.

Step 5. Performance of calculations of the inverse M1 model, on the basis of which the reserves of improvement of indicators necessary for achievement of the reference state are estimated.

Step 6. Selection of a set of the most effective solutions (including digital) to achieve a benchmark level of development of the economic entity for this context.

The first three steps in the presented sequence make it possible to comprehensively characterize and analyze the competitive environment of business, to determine the possibilities of development of economic entities in this context. The quality of implementation of the first stage depends on the level of training of the analyst. At the same time, the high level of his qualification should be complemented by advanced technologies of analytical work and studies. Stakeholder requirements analysis is a work related to a wide variety of information sources:

- Information generated in automated control systems with different stakeholders,
- Results of the analysis of regulations,
- Data analysis of social networks, available Internet Analytics,
- Information obtained in direct interaction with stakeholders.

Therefore, the use of modern work with information, such as machine learning, big data analysis, creates significant advantages for the quality of analysis of the requirements of stakeholders [11].

The second and third steps can be standardized and automated. These stages of analysis are particularly important, as they provide an independent from the preferences of the analyst assessment of the state of the effectiveness of the estimated economic entities. This analysis conditionally allows for a wide variation in the weights of the various parameters of the M1 model, reflecting the different preferences of key stakeholders and their requirements. This allows a more complete analysis of the context of the functioning and development of economic entities, taking into account their heterogeneity. At the second stage, the composition of the reference group is determined, which is a key point and a means of further research. On the third step, the proposed method contains the calculation and evaluation of indicators of the structure of a set of economic entities on certain grounds, indicators of comparison of their characteristics with reference and other indicators, comprehensively representing the results of the calculation of the M1 model. One of the tasks to be solved in the course of this analysis is to estimate the number of economic entities seeking the conditions of a certain standard. Thus, it is possible to assess the direction of development of the majority of economic entities and to identify a modal standard.

The method of shell data analysis involves measuring the so-called cross-efficiency, which is measured by evaluating the sum of the efficiency values obtained by substituting all the weight values. However, it is not advisable to adapt this analytical technique to the tasks of benchmarking at the moment. The differentiated approach based on the principles of the theory of stakeholders, sustainable development, used in the proposed reference analysis, does not allow averaging the results of the functioning of enterprises, i.e. to bring them into a single class. The allocation of several classes, alternatives to functioning in accordance with their existing social, environmental and financial capital, expressing the need for strategic features, allowing for a variety of business models used, will allow to compare their effectiveness, which are interested in relevant stakeholders in relation to this class.

Starting from the fourth step of the proposed methodology, it is assumed to actively use information related to the specific economic entity of heterogeneous population. Information which is used about the individual strategic vision of the economic entity, as well as the business model used for this purpose. The role of stakeholders in the implementation of the business model is evaluated, which allows to clarify the range of permissible values and limitations of weight characteristics.

The quality of the analyst's work on the fourth step allows us to determine in the next stage, in which direction and how much the level of indicators should change to achieve the optimal level of compliance with the requirements of main stakeholders. If the method of shell data analysis is used to evaluate the integral performance indicator, then this state of indicators is primarily characterized by a conditional value of the integral index (relative efficiency) equal to 100 %. At this stage, the composition of the relevant reference group, i.e. those standards that implement the closest business models for a particular economic entity, is revealed.

The analysis made in this way allows us to judge to which organization of the relevant group the target state of the organization of interest is most or least close in the context of each indicator. The assessment of the influence of the relevant group can determine some strategic decisions made by organization, identify the main competitors, and study the features of the functioning of enterprises on the most preferred qualities for this.

The solution of the inverse model M1 allows determining the necessary reserves for improvement of indicators to achieve the reference states. This model of the mathematical programming problem takes into account a number of important points:

- The preferences revealed as a result of the analysis of stakeholder requirements will be reflected not only in the weight values of the model parameters, but also in the limitations of the parameters themselves;

- The potential impact of digital and other solutions on individual parameters will be taken into account. Not all of the parameters required by the stakeholders can be changed. Thus, for example, the requirements of legal compliance of the organization's activities, which are formulated in the legislation of the state or its region, must be met strictly to a certain measure. At the same time, the model should take them into account if in this context such requirements do not apply to the whole set of analyzed economic entities;

- The model also takes into account the priority of some requirements to others, which may also be due to the context of the functioning and development of the business.

The identified reserves determine the scale of future business changes and allow determining a set of solutions to achieve the benchmark level of development of an economic entity for this context. The effectiveness of digital solutions is evaluated based on the analysis of the volume and cost of resources involved in the processes of their implementation, as well as assessing the reduction of gaps between the expected state of the economic entity and its standard.

It should also be understood that the implementation of benchmarking should be carried out continuously, since the improvement of the economic entity leads to a change in the context of its functioning, and hence the standards change.

IV. CONCLUSION

As a result of the study of changes in the conditions of functioning of modern economic entities revealed the need for the development of analytical approaches aimed at solving new management aims and goals. In order to assess the reference state of the organization, which reflects the most preferred level of compliance with the requirements of stakeholders, it is necessary to take into account the orientation of modern companies to maximize the implementation of social, environmental and economic requirements of various stakeholders. The identification of the reference state is associated with the study of variations in the implementation of the requirements of stakeholders by a variety of economic entities. However, the traditional taxonomic approach to assessing the standard requires an alternative, since it is based on the assumption of homogeneity of the set of economic entities. New conditions for the functioning of modern economic entities pose to analytical science the task of forming and developing approaches, methods, techniques that can scientifically determine the composition of standards in the aggregate of economic entities. The study defines a set of principles for the reasonable allocation of standards in a heterogeneous set of economic entities. It is proposed to adapt the mechanism of shell data analysis for the method of reference analysis. As a result of the study, the main stages of the method of reference analysis in the conditions of heterogeneity of economic entities are determined.

The proposed method allows carrying out the necessary comparative analysis of heterogeneous economic entities to assess the effectiveness, which meets the current conditions, when the range of key stakeholders has significantly expanded and organizations are guided by the strategy of sustainable development. The proposed method allows carrying out the necessary comparative analysis of heterogeneous economic entities to assess the effectiveness, which meets the current conditions, when the range of key stakeholders has significantly expanded and organizations are guided by the strategy of sustainable development [12].

The definition of a set of standards also makes it possible to identify the real requirements of stakeholders and to eliminate the unreasonably high level of requirements registered as a result of their monitoring. For organizations in a number of sectors of the economy, this can be difficult, because not all economic sectors fully disclose information about the actual state of the indicators reflecting the key areas of operation. The solution to this problem is seen in the prospects for the development of the practice of publishing non-financial reporting.

The well-established trend towards increasing heterogeneity of economic actors suggests that it is necessary to develop approaches and management methods that take into account the composition and requirements of key stakeholders. The variety of solutions for the digitalization of the functioning of economic entities is growing, so the quality of assessing the effectiveness of their implementation becomes a necessary condition for the successful digitalization of the

domestic economy to develop a sound strategy for digitalization.

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