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DEVELOPMENT OF A MECHANISM FOR ADAPTING DIGITAL INNOVATION POTENTIAL OF AN ORGANISATION WITH ALLOWANCE FOR PECULIARITIES OF DIGITAL INNOVATION PROJECTS

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Abstract

This paper is devoted to the problem of forming the innovation potential of an organisation that implements digital innovation projects. The authors have developed a mechanism for adapting the digital innovation potential (DIP) of an enterprise to the strategic goals and objectives of its innovative development, taking into consideration the factors of the innovation climate and internal environment. The relevance of the study is rooted in the increasing dynamism, unpredictability, and turbulence of the external and internal environments of organisations and the high rate of implementation of advanced digital technologies. These changes should be reflected in enterprise management systems, including innovation management systems. Different types of digital technologies are characterised by specific factors of development and implementation. This determines the peculiarities in the formation of the innovation potential required to implement such projects, as well as the ambiguity of the number and composition of analytical indicators in its evaluation. The theoretical and methodological basis of the study were the publications of international and Russian authors devoted to the problems of adapting economic systems to the conditions of a dynamically changing environment, as well as the study of the essence, formation, and evaluation methods of the innovation and digital potential of an organisation. The paper presents the author's interpretation of the concept of digital innovation potential. The authors substantiate the sequence of stages for identifying priority areas of adaptation and development of necessary measures for the formation of the target level of digital innovation potential, and propose a methodology that allows identifying key factors and determining the degree of influence for each of them. Based on the developed methodology, the most significant areas of adaptation of the digital innovation potential of an oil and gas enterprise during implementing the project of introducing virtual and augmented reality technologies were identified.

Keywords: digital innovation projects; innovation potential of an organisation; adaptation mechanism; innovation climate; external and internal environment factors; digital technologies

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РАЗРАБОТКА МЕХАНИЗМА АДАПТАЦИИ ЦИФРОВОГО ИННОВАЦИОННОГО ПОТЕНЦИАЛА ОРГАНИЗАЦИИ С УЧЕТОМ ОСОБЕННОСТЕЙ ЦИФРОВЫХ ИННОВАЦИОННЫХ ПРОЕКТОВ

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Аннотация

Статья посвящена проблеме формирования инновационного потенциала организации, реализующей цифровые инновационные проекты. Авторами разработан механизм адаптации цифрового инновационного потенциала предприятия к стратегическим целям и задачам его инновационного развития с учетом факторов инновационного климата и внутренней среды. Актуальность исследования обусловлена ростом динамичности, непредсказуемости и турбулентности внешней и внутренней среды организаций, высокими темпами внедрения передовых цифровых технологий. Эти изменения должны находить отражение в системах управления предприятиями, в том числе в системах управления инновационной деятельностью. Различные виды цифровых технологий отличаются специфическими факторами разработки и внедрения, это обуславливает особенности в формировании инновационного потенциала, необходимого для реализации таких проектов, а также неоднозначность количества и состава аналитических показателей в его оценке. Использование предложенного авторами механизма позволит обеспечить необходимый уровень цифрового инновационного потенциала для эффективной реализации цифровых проектов. Теоретическую и методологическую основу исследования составили публикации зарубежных и российских авторов, посвященные проблемам адаптации экономических систем к условиям динамично меняющейся внешней среды, а также изучению вопросов сущности, формирования и методов оценки инновационного и цифрового потенциалов организации. В работе дана авторская трактовка понятия цифровой инновационный потенциал. Обоснована последовательность этапов по выявлению приоритетных направлений адаптации и разработке необходимых мероприятий для формирования целевого уровня цифрового инновационного потенциала, предложена методика, позволяющая выявить ключевые факторы и определить степень влияния каждого из них. На основании разработанной методики выявлены наиболее значимые направления адаптации цифрового инновационного потенциала предприятия нефтегазовой отрасли при реализации проекта внедрения технологий виртуальной и дополненной реальности.

Ключевые слова: цифровые инновационные проекты; инновационный потенциал организации; механизм адаптации; инновационный климат; факторы внешней и внутренней среды; цифровые технологии.

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1. Introduction

The current development stage of the global and Russian economic systems is characterised by the following features: (1) increasing dynamism, unpredictability, and turbulence of external and internal environments and (2) the high rate of adoption of advanced digital technologies (Issa et al., 2018; Schumacher et al., 2018). The introduction and use of advanced digital technologies allows companies in various sectors of the economy not only to reduce costs but also to transform existing business models, providing themselves with competitive advantages in the global market. Today, digital technologies are the main driver of their sustainable development and the main tool for enhancing their competitiveness and investment attractiveness. All these changes should be reflected in enterprise management systems, including innovation management systems. The current digital transformation requires developing and improving methods for managing digital innovation projects to improve the efficiency of companies and maintain a leading position in a competitive and high-tech market.

Strategic goals of innovative development of an organisation are achieved through implementing innovation and investment projects characterised by creation of digital products, focus on improving the existing and developing new business models, high level of uncertainty, high technological and organisational complexity, critical pace of implementation, focus on new needs, and use of agile approaches to project management (Shmeleva et al., 2019). Since different types of digital technologies are characterised by specific factors of development and adoption, they also determine the peculiarities in the formation of the innovation potential required to implement such projects, as well as the ambiguity of the number and composition of analytical indicators in their evaluation (Aldea, 2018).

The purpose of the research was to develop a mechanism for adapting the digital innovation potential (DIP) of an enterprise to the strategic goals and objectives of its innovative development, taking into consideration the needs of digital innovation and investment projects.

2. Literature Review

Currently, many scientific papers presented by leading international and Russian scientists are devoted to the formation of the innovation potential of organisations, but the tools proposed in them do not provide enough flexibility to respond to external changes and to quickly adapt to them, and do not take into consideration specifics of digital innovation projects. In particular, the problems of adapting economic systems to the conditions of a dynamically changing external environment are the subject of research by Chanias et al. (2019) and Park et al. (2021). The essence, formation, and methods of evaluating the innovation and digital potential of economic systems have been studied by scientists such as Babkin et al. (2021), Eremin et al. (2019), and Kotarba (2017).

To clarify the concept of "innovation potential" with allowance for the features of digital innovation projects, we conducted a review of different approaches to its interpretation. One of the most common is the resource-based approach, in which innovation potential is understood as an ordered aggregate of the various resources necessary for carrying out innovation activities. The evaluation methodologies of different authors differ in the set of resource groups and the list of components. However, it should be noted that the same set of resources does not provide the same result of innovation activity; therefore, the innovation potential in an organisation may be limited by internal barriers that do not allow it to be properly harnessed.

From the point of view of a number of authors, innovation potential can be considered a measure of an enterprise's ability to create, introduce, and disseminate new ideas, technologies, and products. In this case, the focus is on the effectiveness of its use. Thus, in accordance with the results-based approach, innovation potential is characterised by the totality of the results of the innovation activity. Advocates of the systematic approach consider innovation potential to be the ability of an economic system to change, improve, and progress based on the transformation of available resources into a qualitatively new state.

The approaches considered above do not contradict each other; each reveals one aspect of innovation potential. However, we believe that the concept of innovation potential is broader and includes the analysis of the organisation's ability to implement innovation projects related not only to digitalisation. In this regard, there is a need to clarify this category, taking into consideration the specifics of implementing digital innovation and investment projects.

We examined the approaches of various authors to the interpretation of the concept of "digital potential" (Babkin et al., 2021; Salko, 2021, Kozlov et al., 2019). The review of the scientific literature showed that most sources focus on groups of factors directly related to the adoption of information and communication technologies. Some authors suggest limiting consideration solely to the digital component of the organisation's potential.

In our opinion, when analysing the readiness of an enterprise to implement digital innovation projects, it is advisable to use the concept of "digital innovation potential", and its evaluation requires a balanced approach that takes into consideration both the level of resources for the implementation of digital innovation projects and the organisation's ability to implement such projects. From such a perspective, the factors of the digital component should have greater weight in the formation of this potential (Sola et al., 2021).

3. Materials and Methods

The methodological basis of the study was the works by international and Russian authors in the field of formation and evaluation of innovation potential of economic systems, adaptation, and adaptability of organisations in a changing environment, as well as management of digital innovation and investment projects (Shmeleva et al., 2021; Zhu, 2021). When developing the mechanism of adaptation of the digital innovation potential of an organisation, we used general scientific research methods, in particular methods of system analysis, SWOT analysis, comparative analysis, the expert scoring method, the method of calculating the Kendall rank correlation coefficient, the method of assessing the consistency of experts using Pearson's chi-squared test and tabular and graphical methods of data interpretation (Muñoz-La Rivera et al., 2020).

The study included several stages. In the first stage, based on the analysis of the previously described sources, we synthesised our interpretation of the concept of digital innovation potential. We defined DIP as the ability of an enterprise to effectively solve the problems of innovation activities using digital technologies, both within the existing business processes and transformed on the basis of new technological capabilities, with optimal use of available resources, which enables moving the enterprise to a qualitatively new state. Next, we analysed the factors that determine the level of the digital innovation potential of an enterprise. Figure 1 shows the process of formation of the actual level of digital innovation potential under the influence of factors of the external and internal environments of the organisation.

In the next stage of the study, we developed the mechanism of adapting the innovation potential of an organisation to the objectives of its innovative development, which can be represented in the scheme illustrated in Fig. 2. The specifics of this mechanism for digital innovation projects are expressed in a set of factors subject to analysis.

The *adaptation mechanism* is understood as a system of interrelated elements that includes the principles and functions of adaptation management, as well as the subject's leverage on the object to achieve the goal. The following structural elements can be distinguished with regard to the adaptation mechanism of the organisation's digital innovation potential:

Goal: Adaptation of the digital innovation potential of an organisation for effective implementation of a digital innovation project.

Management entity: The project's management committee is the main collegial decision-making body of the project, and includes representatives of the customer and the executor, if the project is implemented by a third-party organisation. The committee finds importance in carrying out activities that are beyond the authority of the project manager at the target level of the innovation potential.

Object of management: This refers to the innovation potential of an organisation that introduces digital technologies.

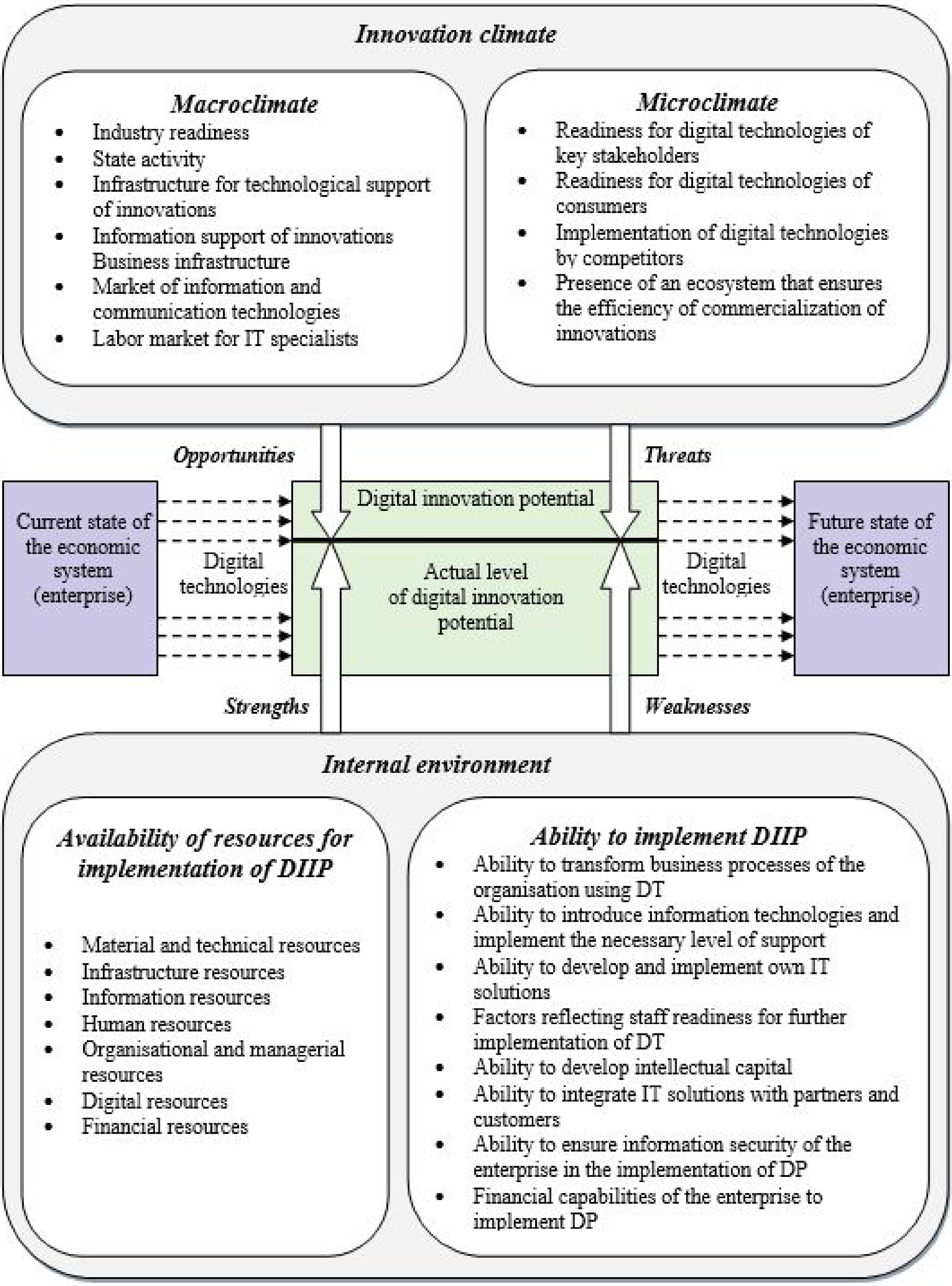


Figure 1. The process of forming the actual level of the digital innovation potential of an organisation

The *main principles* in this case are consistency, flexibility, and adaptability.

Management functions are presented in the form of the following blocks: analysis includes selecting priority areas of adaptation of the innovation potential; planning – development of a portfolio of adaptation programmes; organisation implies implementation of these programmes; control – monitoring and regulation in the form of feedback. The formation of a portfolio of adaptation programmes is the development of a programme of specific actions to bring the level of individual elements of the innovation potential to the required level. If the project is long-term, there will always be elements of the potential that need to be adjusted due to dynamic changes in the conditions of project implementation.

The choice of *leverage* for specific elements of the innovation potential (adaptation tools and the means to provide them) is made at the planning stage.

Result: This captures the formed level of innovation potential necessary for the effective implementation of a digital innovation and investment project.

The degree of influence on the implementation of an innovative project of various factors from the considered groups can vary significantly; therefore, it is necessary to identify the most important factors and evaluate the level of influence of each of them. Such gradation is important because when developing a portfolio of adaptation programmes, it is advisable to focus resources on the main areas rather than waste them on factors that have a weak impact on the project (Shmeleva et al., 2020). The level of factors' target values and the need for adaptation measures depend on the significance of factors for implementing digital projects.

Following the crafting of the adaptation mechanism, we then proposed a methodology that allows identifying the key factors in the formation of digital innovation potential and determining the degree of influence for each of them. Figure 3 shows a matrix set that allows the identification of the priority areas of adaptation. For this purpose, with the expert analysis, an evaluation of the level and significance of factors for implementing a digital innovation project was carried out. We developed a matrix set consisting of four matrices for analysing the strengths and weaknesses of the current state of the organisation's innovation potential, as well as opportunities and threats to achieve its target level. Further, guidelines were developed regarding the factors from the various quadrants of the matrix set.

S_I and O_I were factors that were highly evaluated by experts and also have a significant impact on the effectiveness of project implementation. Any action in relation to the factors from the S_I group should be taken only if there is a tendency for their level to decrease and the possibility of moving into the second group. Factors of the O_I group should be included in the group of priority areas for the adaptation of the innovation potential.

S_{II} and O_{II} were factors to which experts assigned low scores while highly rating their impact on the possibility of successful project implementation. Therefore, it is necessary to concentrate efforts on the intensive development of the factors of the S_{II} group. For the external environment factors O_{II}, it is necessary to provide alternative options for the use of opportunities to reduce their significance. Given that the impact of factors from groups S_{III}, O_{III}, S_{IV}, O_{IV} on implementing an innovation project is insignificant, it is sufficient to maintain S_{III} and S_{IV} at the current level, and exclude the use of groups O_{III} and O_{IV} factors from further analysis.

W_I and T_I are internal and external risk factors. Their impact is considerable on a project, and the probability of their occurrence during its implementation is also significant. It is necessary to pay close attention to these factors. To make a decision on actions in relation to the factors in this group, it is necessary to analyse which activities for their minimisation can be carried out with the least expenditure of time and resources. Depending on the results of the analysis, anti-risk measures should be implemented to move the W_I factors to the second group by reducing the level of risk, and factors from the T_I group to the third group by reducing the impact.

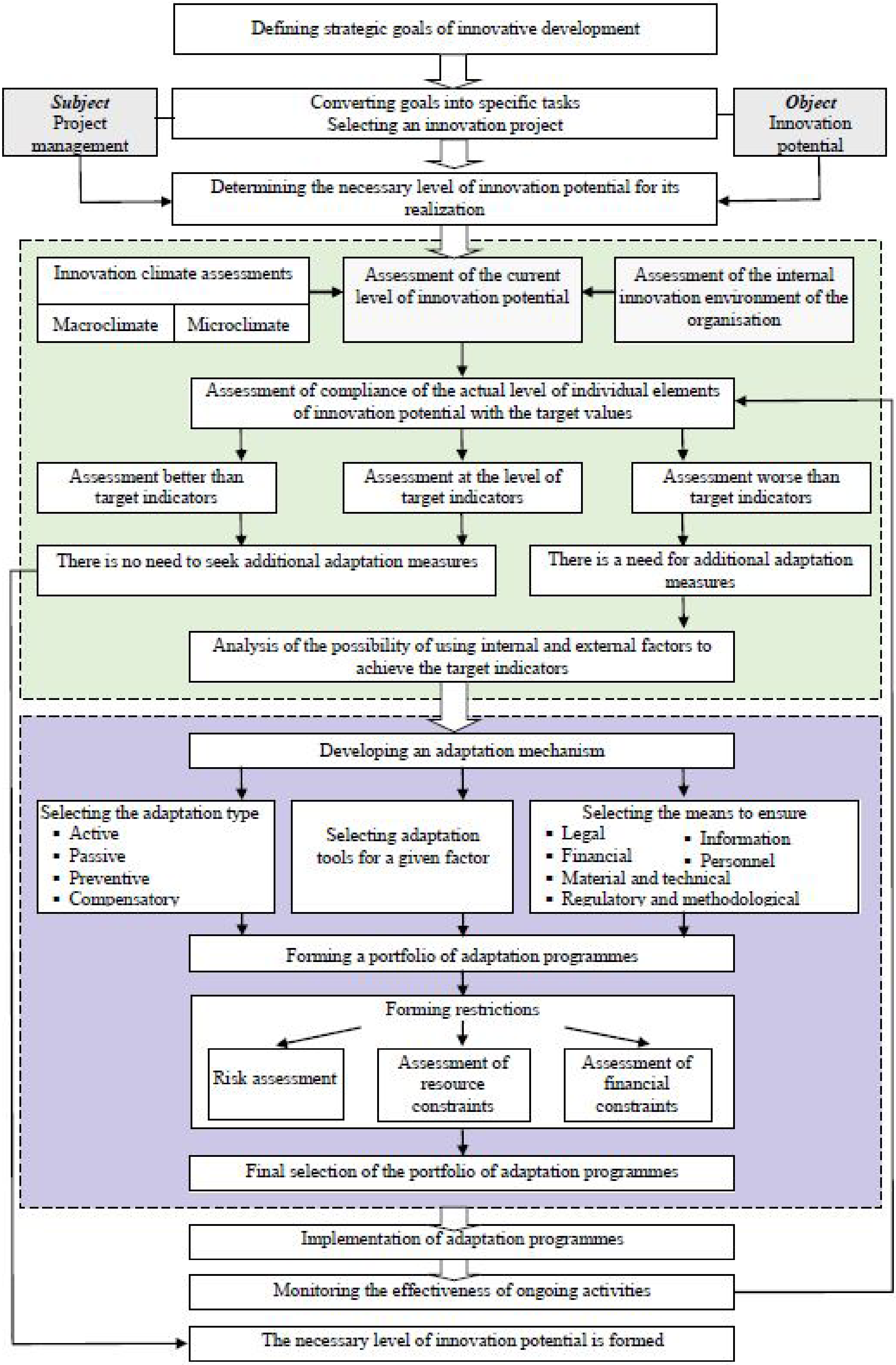


Figure 2. Mechanism of adaptation of the digital innovation potential of an organisation

W_{II} and T_{II} are threat factors, the negative impact of which was recognised by the experts as significant, but the level of probability of their occurrence was found to be insignificant. Despite the low probability of occurrence, the elements of these groups require special attention due to the significant negative consequences of a project. For these factors, anti-risk measures should be taken to reduce the degree of their impact, which will allow them to move to the fourth group.

W_{III} and T_{III} are risk factors whose negative impact was not rated highly by the experts, although they noted a significant probability of their occurrence. Although the factors in this group were not rated highly enough for their impact on project implementation, the high probability of their occurrence makes it necessary to pay close attention to possible consequences due to the negative impact on the project at later stages of its implementation. In relation to the elements of this group, it is necessary to develop anti-risk measures to reduce the probability of their occurrence and move them into the fourth group.

W_{IV} and T_{IV} are factors that were given low scores by the experts in terms of their impact on a project, and their probability of occurrence was also found to be low. The elements from these groups can be excluded from further planning of anti-risk measures.

From the analysis, we can conclude that the main efforts should be concentrated on groups S_{II}, O_I, O_{II}, W_I, T_I, and W_{II}. The areas of adaptation corresponding to these factors should be recognised as a priority.

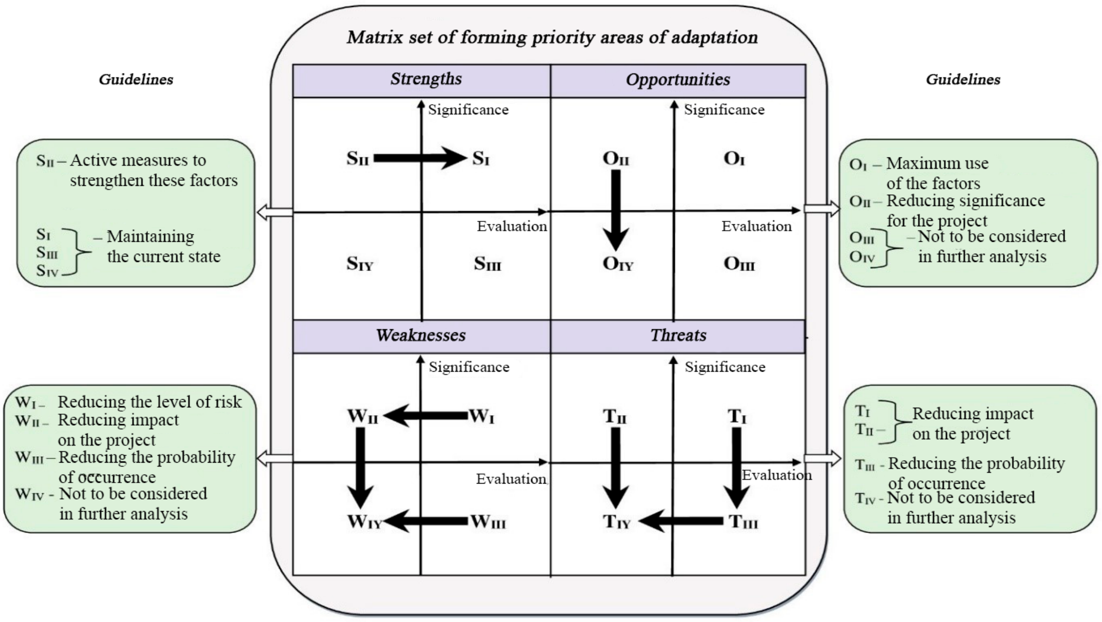


Figure 3. Matrix set for forming priority areas of adaptation

For a quantitative assessment of the level and significance of the factors from the matrix sets, we used the expert evaluation method, given that most of the identified factors are difficult to assess quantitatively. The method also allows for combining their assessments with a single quantitative measure. In assessing the level of innovation potential, we considered only internal factors, which allowed for assessing the readiness of an organisation to implement the innovation project under consideration. In forming the priority directions of adaptation, all four groups of factors were assessed for their possible impact on the formation of the necessary level of the innovation potential of the external environment factors.

The integral indicator of the innovation potential *IIP* is calculated on the basis of the assigned scores according to the formula:

$$I_{IP} = \frac{\frac{\sum_{i=1}^{n} d_i^S * S_i}{n}}{\frac{\sum_{j=1}^{m} d_j^W * W_j}{m}} \quad (1)$$

where: n is the number of strength factors, *m* is the number of weakness factors, S_i is the estimate of the level of the i-th strength factor, d_i^S is the significance of the i-th strength factor, W_j is the estimate of the level of the j-th weakness factor, and d_j^W is the significance of the j-th weakness factor.

4. Results and Discussion

4.1. Identification of external and internal environment factors of an organisation, affecting the formation of digital innovation potential

The proposed methodology for forming priority areas of adaptation was tested in developing a project that introduced virtual and augmented reality technologies into the processes of training employees of maintenance crews and performing repairs of downhole equipment, which was planned for implementation at the company Gazprom Neft.

The prerequisites for initiating the project are as follows:

– The need for a wide range of specialists due to the complexity and variety of equipment used in the oil and gas industry, which was complicated by the remoteness of facilities and difficulties with logistics;
– Production losses due to downtime of the well stock because of long-time waiting for workover and maintenance crews in the case of well shutdowns;
– The risk of oil pipelines freezing in winter due to forced downtime, which led to fluid fluctuations in the collection system, increased line pressure in upstream pipelines, and the operation of booster pump stations and oil metering units in an abnormal mode;
– The lack of effective coordination of crews in the well repair process led to an increase in non-productive repair time, which increased the time and cost of well workover and maintenance activities (Azieva et al., 2021; Panjaitan et al., 2021).

Reducing equipment downtime and improving the quality of repair works can be accomplished through the use of augmented reality (AR) technology. The following functions can be implemented in an AR system: visualisation of necessary actions of experts, highlighting details that require special attention in a 3D model, display of process parameters in real time and their values in dynamics as trends; display of expert advice in the form of a scrolling text, video communication with an expert and a service engineer directly as a single viewing window, and output of analytics and service information documents (Garcia et al., 2019).

In addition to the prerequisites related to technical difficulties, the company faced some problems related to employee training, namely:

– practical training is possible only during planned shutdowns;
– lack of understanding of the real level of knowledge of employees before certification;
– the need for long training of maintenance crews for downhole equipment leads to a shortage of qualified personnel;
– incidents of injuries and equipment downtime due to employee errors (Flaksman et al., 2020).

The content of a virtual reality (VR) simulator would enable the creation of an exact copy of the workplace and downhole equipment, generating scenarios for operational switching and undergoing both full-fledged training and testing. Practical training would not take place on real equipment but in classrooms with the use of VR headsets

(Al Qrain et al., 2020). A virtual learning environment would allow for creating training sessions on equipment operation, simulating emergency situations, and reproducing other necessary scenarios for training, as well as providing an opportunity to consider objects and processes that are difficult to trace in reality.

Based on the analysis of external and internal environment factors shown in Figure 1 as well as the source study (Krishnan et al., 2020; Stoianova et al., 2020), we identified the factors most important for the formation of the digital innovation potential of the organisation in implementing a project that introduces virtual and augmented reality technologies (Baker, 2022) (Table 1, Table 2).

Table 1. Internal factors significant for the formation of digital innovation potential

Strengths of the organisation	Weaknesses of the organisation
1. The enterprise has the software necessary to implement VR/AR projects.	1. A diverse equipment fleet, difficulty in scaling, and uniqueness of products for different divisions.
2. The enterprise has the necessary equipment to implement VR/AR projects.	2. Difficulties integrating AR/VR with other information systems.
3. The possibility of timely and secure access to databases, ensuring a high level of reliability, accuracy, and quality.	3. Insufficient ability to ensure the information security of the enterprise when implementing digital projects.
4. High level of access to modern digital infrastructure: data processing centres, cloud solutions and working on all types of devices.	4. Simultaneous launch of several disparate «digital» projects that are not tied to strategic goals, which end up being insufficiently successful.
5. The use of process management methods and the readiness of the organisation to change business processes in accordance with the objectives of digitalisation.	5. The long process of alignment and approval of the transition to new business processes using AR/VR.
6. There is a well-established process for creating new digital products, including product analytics and end-to-end integration of development and maintenance processes.	6. Fragmentary introduction of AR/VR technologies, implementation of only pilot versions, weak effects of digitalisation.
7. High level of organisational culture that supports innovation processes, and change management processes.	7. When forming teams, specialists with in-depth knowledge of the specifics of production are not included.
8. Availability of employees capable of developing and implementing their own IT solutions.	8. Conservatism: the reluctance of managers to restructure the models of process organisation accumulated over the years.
9. Employees have the necessary competencies to perform their functions using information systems.	9. Reluctance of the workforce to retrain and extensively use digital technologies.
10. Availability of employees capable of generating non-standard ideas and developing innovative solutions.	10. Employees do not have the necessary competencies to implement digital projects.
11. Availability of a top-level executive in the company, who supervises VR/AR implementation and has the necessary competencies.	11. Low level of interest and engagement of potential users due to mistrust in the effectiveness of digital products.
12. Ability to form feedback from users in order to create a product with the necessary characteristics.	12. Inconsistency of the finished product with functional and business requirements due to a lack of regular interaction with the customer.
13. The existence of a large number of departments, which in the future may use the developed products to improve efficiency, the use of economies of scale.	13. Absence of clear mechanisms for calculating the effectiveness of introducing AR/VR technologies.
14. The enterprise has extensive financial capabilities to implement digital projects.	14. Lack of economic incentives for the enterprise to implement digital technologies, no possible positive effects of implementation have been identified.

Table 2. External factors significant for the formation of digital innovation potential

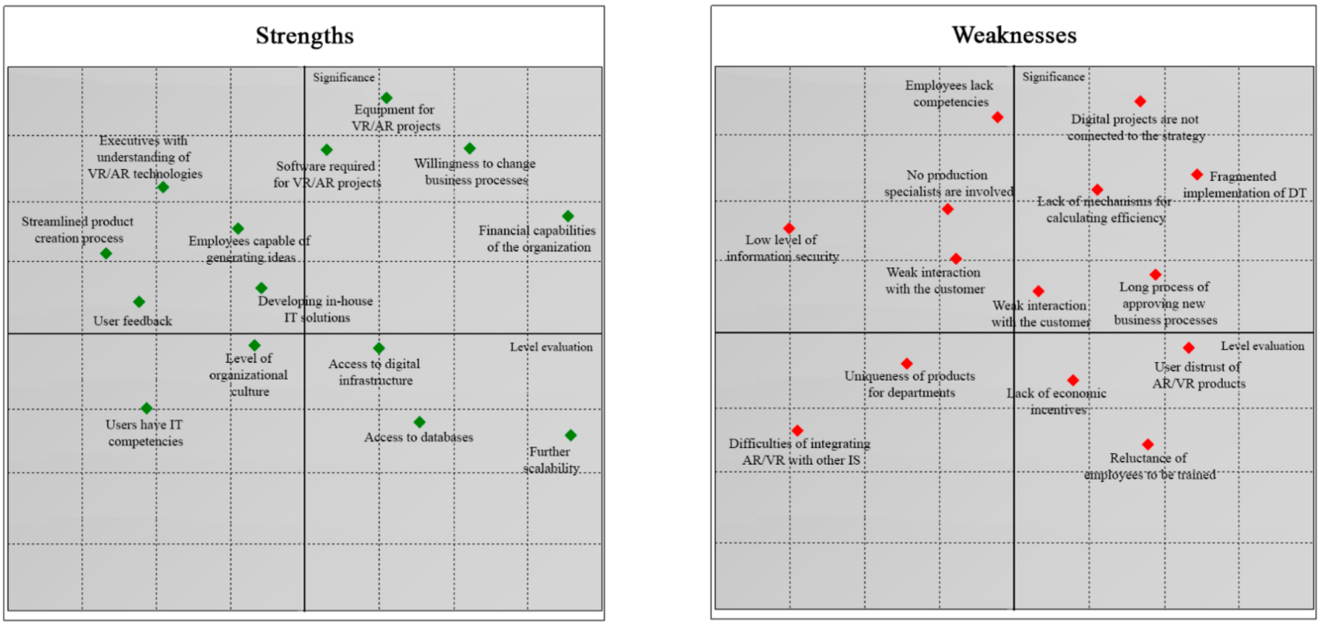
Opportunities	Threats
1. High dynamics of technological development of VR/AR devices and the necessary software.	1. Problems with access to certain types of IT resources required to implement digital technologies.
2. Capacity and availability of external data banks in the field of VR/AR technology.	2. Due to import substitution, it is impossible to use the most advanced AR/VR devices in Russian industrial enterprises.
3. Availability of infrastructure for technological support of VR/AR projects.	3. High level of cyberthreats when implementing digital projects.
4. Creation of leading research centres to effectively solve the tasks of development of sub-technologies necessary for VR/AR.	4. Incomplete legislation regarding the development of the digital economy and the use of ICTs.
5. High degree of readiness of the oil and gas industry to use VR/AR technologies.	5. Implementation of digital technologies by competitors, increasing their competitiveness.
6. Availability of an ecosystem that ensures the efficiency of the commercialisation of innovations.	6. Key stakeholders are not ready for digital technologies.
7. Clearly defined prospects for the use of VR/AR technologies, the development of roadmaps for development.	7. Difficulties with certification of educational VR/AR courses and licensing of VR/AR products.
8. Intensive legislative activity of the state at all levels of government to enhance the implementation of digital technologies.	8. High cost of high-skilled labour due to increased demand in the labour market.
9. Availability of training and retraining structures for competencies required for implementation of digital projects.	9. There is a market deficit of specialists in various fields with the competencies necessary for implementing VR/AR technologies.
10. Opportunities to use digital platforms to quickly find specialists with the necessary competencies.	10. Rapid obsolescence of technologies, inconsistency of AR/VR product with consumer expectations.
11. Technical and psychological readiness of consumers to use VR/AR technologies.	11. Low level of adaptation of the technology for users, not achieving target indicators for the development of sub-technologies.
12. Reduced cost of hardware and software for VR/AR projects.	12. High cost of AR/VR technologies and the required equipment.
13. Financial preferences of the state for companies that develop digital technologies (grants, co-financing, soft loans).	13. High cost of providing infrastructure for technology implementation.
14. Developed business infrastructure, including investment companies, banks, insurance companies, stock exchanges, etc.	14. Insufficiently developed system for ensuring the legal, economic, and financial security of participants.

In the quantitative analysis of the factors, we asked experts to evaluate the factors of each group on a five-point scale. The results of the survey made it possible to assess the level and significance of the strengths and weaknesses of the organisation's digital innovation potential for effective project implementation, as well as the impact of opportunity and threat factors on the formation of the digital innovation potential. After each stage of the evaluation, tables of results were compiled, and the degree of consistency of expert opinions was determined on the basis of Kendall's coefficient of concordance. For a more accurate calculation, we used Pearson's chi-squared test.

The resulting value of the integral indicator of the digital innovation potential $I_P < 1$ indicates that the weaknesses of the digital innovation potential of the organisation exceed the strengths, indicating the need for measures to adapt it to the objectives of the project.

4.2. Identification of priority areas of adaptation of the digital innovation potential based on the analysis of matrix sets

Relying on the information obtained from the expert evaluation, matrix sets of “Strengths”, “Weaknesses”, “Opportunities”, and “Threats” were created, the analysis of which made it possible to identify the most significant areas of adaptation of the organisation’s innovation potential to the tasks of implementing AR/VR projects (Garcia et al., 2019; Lokuge et al., 2018) (Figure 4, Figure 5).



(a) (b)

Figure 4. Matrix set of (a) “Strengths” and (b) “Weaknesses”

Matrix “Strengths”

The SI quadrant included the strengths of the organisation, which, in the opinion of experts, can have a significant impact on the effectiveness of project implementation. These included “Willingness to change business processes” and “Financial capabilities of the organisation”. This group also included such factors as “Equipment for VR/AR projects” and “Software required for VR/AR projects”. However, in connection with an insufficient level of development of sub-technologies, which are basic for the implementation of a content of necessary quality, it is necessary to constantly monitor the latest trends in their development and to use the most interesting ideas in designs.

The SII category included factors that were scored low by the experts for their level in the organisation, but they were highly evaluated in terms of their impact on the possibility of successful implementation of the project. It is necessary to concentrate efforts on the intensive development of the factors in this group. This quadrant included “Ability to develop in-house solutions” and “Availability of employees capable of generating ideas” due to the lack of specialists in the labour market with the necessary competencies and the lack of experience with VR/AR among the company’s existing employees. The same group included the factor “Availability of executives with understanding of VR/AR”. According to the findings, the organisation’s top managers have insufficiently formed competencies related to the use of digital technologies, resulting in reluctance to restructure process organisation models accumulated over the years. To increase the level of factors “Feedback from users” and “Streamlined product creation process”, flexible development methodologies should be used, and business processes of creating new digital products, including product analytics and end-to-end integration of development and maintenance processes, should be improved.

Quadrant SIII included “Access to digital infrastructure” and “Access to databases”. These factors were sufficiently developed in the organisation; thus, they only need to be maintained at the current level in the future. Due to the fact that "Gazpromneft" had a large number of divisions that could further use the developed products, the organisation could further scale pilot projects to other departments and use the economies of scale to improve the efficiency of its activities.

The SIV factors "Level of IT competencies of users" and "Level of organisational culture" of the company were significant for the project, but they did not have a critical impact on it. Strengthening these factors is important for improving the overall digital culture of the organisation.

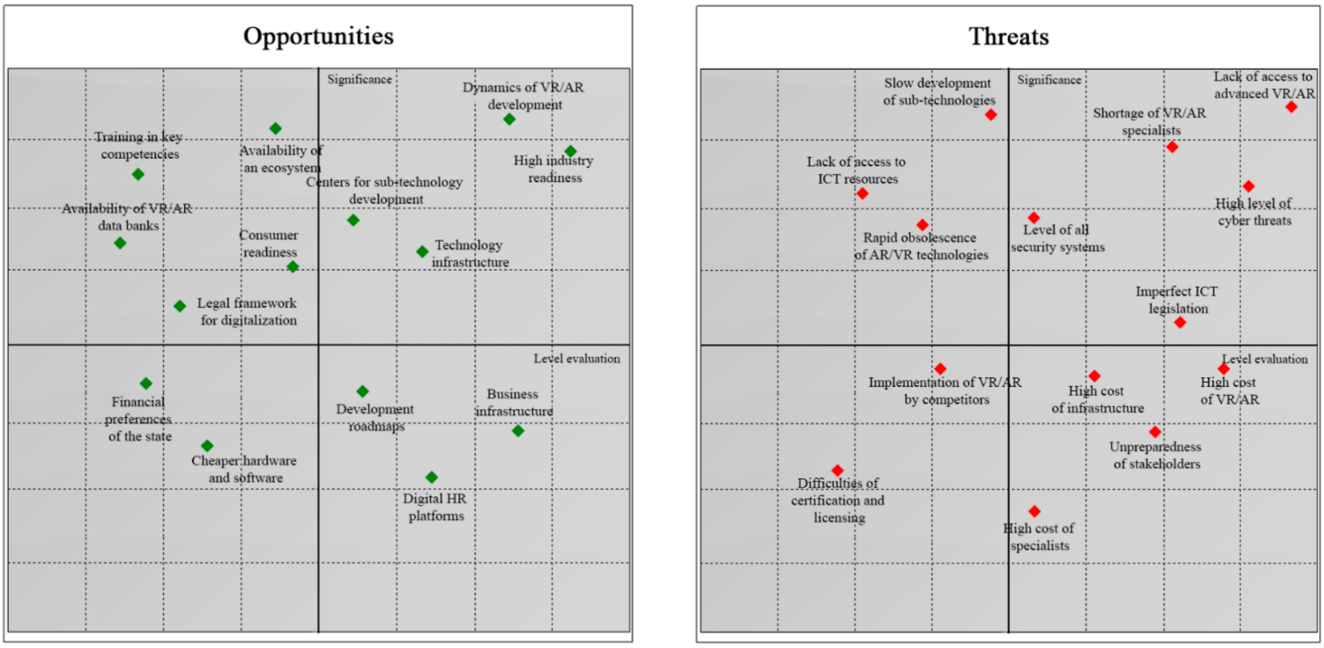
Matrix "Weaknesses"

The WI quadrant included internal risk factors with high impact and a significant probability of occurring during the implementation of the project. These included "'Digital projects are not connected to the strategy" and "Lack of clear mechanisms for calculating the effectiveness of implementation". Thus, several disparate projects were launched simultaneously, resulting in insufficient success. Fragmentary implementation of AR/VR technologies and the implementation of only pilot versions led to the weak effects of digitalisation. This group also included "Conservatism of leadership" and a lengthy "Process of alignment and approval of the transition to new business processes" with the use of AR/VR. Often, this was due to a lack of confidence in the effectiveness of using digital products. These factors need to be given close attention. To decide on actions regarding the factors in this group, it is necessary to analyse which activities for their minimisation can be performed with the minimum amount of time and resources. Depending on the results of the analysis, it is necessary to implement anti-risk measures to move the WI factors into the second group by reducing the level of risk.

The WII category included factors whose negative impact on AR/VR projects was recognised by experts as significant, but their occurrence was not as significant. This was a result of project teams that became inefficient, as participants did not always have enough competencies to implement digital projects, and the teams did not include specialists with deep knowledge of the specifics of production. Additionally, it is worth noting the likelihood of inconsistency of the finished product with functional and business requirements due to the lack of regular interaction with the customer, which can be avoided by using agile development methods. The level of information security in the organisation was quite acceptable.

Quadrant WIII represents the weaknesses of the organisation, the negative impact of which was not highly evaluated by the experts, who, however, noted a significant probability of their occurrence. The factors of this group were closely interrelated. Due to the fact that the possible positive effects of the introduction of AR/VR technologies were often not identified, potential users had a low level of interest and engagement, the consequence of which was reluctance of the workforce to retrain and widely use digital technologies. The highly likely occurrence of these factors necessitates careful attention to the possible consequences of the negative impact on the project. In relation to the elements of this group, it is necessary to develop anti-risk measures to reduce the likelihood of their occurrence and to move to the fourth group.

WIV and TIV are factors that were given lower scores by the experts for their impact on the project, and their probability of occurrence was also found to be low. They included the difficulty of integrating AR/VR with other information systems, the diverse equipment fleet, and the uniqueness of products for different departments, which led to difficulties in scaling the technologies.



(a) (b)

Figure 5. Matrix set of (a) “Opportunities” and (b) “Threats”

Matrix “Opportunities”

The OI quadrant included opportunities provided by the external environment of the organisation, which could have a significant impact on the project and were rated highly by experts. One of the most significant opportunities was the high dynamics of the technological development of VR/AR devices and the necessary software. As noted earlier, a fivefold increase in the virtual and augmented reality markets is predicted to occur by 2025 due to the intensive development of sub-technologies. The roadmap for the development of “end-to-end” digital virtual and augmented reality technology includes a set of measures to accelerate their development, including the creation of leading sub-technology research centres (Linnik et al., 2019).

The high degree of readiness of the oil and gas industry to use VR/AR technologies is associated with the strategy development and restructuring of business processes. In connection with tightening competition in the market and the need to reduce costs, there is a high degree of readiness of the oil and gas industry to use advanced digital technologies, including VR/AR. In this regard, the availability of technological support for innovative solutions in the industry is receiving increased attention. Factors in the OI group should be included in the priority areas used to adapt the digital innovation potential of an organisation.

The OII category included factors of the external environment that were important for the project but whose level of development was currently insufficient. This was the legal framework at all levels of government for the support and maintenance of implementation of digital technologies, the capacity and availability of external data banks in the field of VR/AR technologies, and the presence of full-fledged ecosystems that ensure the effectiveness of commercialisation of innovations.

Further, there is no comprehensive state programme or system of structures for training and re-training personnel in the competencies necessary not only for implementing VR/AR projects but also for their further use in professional activities. Currently, the technical and psychological readiness of consumers to use VR/AR technologies is not at a high level and is noted only among certain groups of users.

Quadrant OIII included factors of opportunity, the level of which in the innovation climate is quite high. These include the presence of clearly defined prospects for the use of VR/AR technologies, the creation of development roadmaps, a developed business infrastructure, including investment companies, banks, insurance companies, stock exchanges, etc., and opportunities to use digital platforms to quickly find specialists with the necessary competencies. Since these external environmental factors were sufficiently developed, they need to be maintained at current levels, and the organisation can fully rely on them in forming its digital innovation potential.

Factors in the OIV group were the financial preferences of the state for companies developing digital technologies, as well as reducing the cost of equipment and software for VR/AR projects, which are important for the mass development of these technologies and their penetration into all sectors and areas of life. However, a company planning to implement a virtual and augmented reality project should have high financial potential; therefore, these factors are less significant. Notably, the two factors in this group have yet to show their full potential.

Matrix "Threats"

The TI quadrant includes threats that have a high level in the innovation climate of the organisation and are also of great importance to the innovation project. The most critical threat, according to the experts, was the lack of specialists in the market with the necessary competencies to implement VR/AR technologies. Apart from this, there is the impossibility of using the most advanced AR/VR devices in Russian industrial enterprises due to the import substitution policy and their high cost. Further, when implementing any digital projects, there is currently a high level of cyber threats, namely cyber-attacks, hacking of information systems and databases, the lack of national information security standards, and undeveloped regulatory and legal support for combating cybercrime. All of the above-mentioned factors make digital projects very vulnerable. In this regard, the group of the most significant threats included imperfect legislation in the development of the digital economy and the use of ICT, as well as an underdeveloped system of legal, economic, and financial security of participants.

Category TII included factors whose negative impact on the project was recognised by experts as significant, but the probability of their occurrence was recognised as moderate. In particular, this quadrant included the probability of slow development of sub-technologies as well as problems of access to certain types of IT resources necessary for implementation of digital technologies due to the imposition of sanctions. However, an analysis of trends in recent years, as well as the existence of a large number of measures to support them in regulatory documents, suggests a low probability of the occurrence of this threat. The rapid obsolescence of various technologies, including digital ones, is an inevitable pattern. Despite the low probability of occurrence, the elements of this group require special attention due to the significant negative consequences for the project.

Quadrant TIII included factors with a highly likely occurrence, but their negative impact on this project was assessed by the experts as low. The impact of interactions with key stakeholders on this project was insignificant, as it mainly affected internal business processes. This group of factors also included the high cost of AR/VR technologies and necessary equipment, the high cost of highly qualified personnel due to increased demand in the labour market, and the high cost of infrastructure for implementation of the technologies. Due to the high level of financial potential of the organisation, the factors of this quadrant could not currently have too negative an impact on the project, but the high probability of their occurrence in the future necessitates attention to their possible consequences at later stages of its implementation.

Regarding group TIV, the experts identified the factors whose level and impact on the project were not very significant. The dynamics of implementation of digital technologies by competitors and the increase in their competitiveness should be systematically monitored to make certain changes in strategic plans; however, in this particular project, their actions would not have a significant impact. There were also certain difficulties with the certification of educational VR/AR courses and licensing of VR/AR products. Thus, it is necessary to carefully prepare documentation for these procedures.

This study allowed for the identification of the following priority areas of adaptation of the digital innovation potential of "Gazpromneft":

1. The technological readiness of the organisation where the implementation is carried out should be increased. The compliance of equipment and software for AR/VR solutions should be aligned with the requirements of real production conditions and the use of the latest sub-technologies for the implementation of specific technological solutions. The level of access to modern digital infrastructure, such as data centres, cloud solutions, and working on all types of devices, should be increased. Information security should be ensured.

2. Cross-functional teams with a high level of competencies in the field of VR/AR should be formed to include full-cycle specialists in the field of immersive technologies, employees capable of generating non-standard ideas, and experienced professionals with deep knowledge of the specifics of production.

3. The necessary profile competencies of managers supervising AR/VR implementation in the organisation should be enhanced, which allows understanding potential opportunities of using AR/VR technologies and correctly forming development tasks.

4. The objectives of digital projects should be coordinated with the innovation strategy of the organisation. The disparate, fragmented implementation of AR/VR technologies has led to a significant reduction in the effects of digitalisation. There is a need to increase the transparency of the mechanism for calculating the effectiveness of digital projects.

5. The organisation should be ready to change business processes in accordance with the objectives of digitalisation by simplifying procedures for alignment and approving the transition to new business processes using AR/VR, and increasing the interest and involvement of potential users.

5. Conclusion

In this paper, we propose a mechanism for adapting the innovation potential of an enterprise to the strategic goals and objectives of its innovative development, taking into consideration the factors of the innovation climate and the internal innovation environment of the organisation. We interpreted the concept of digital innovation potential based on the analysis of specific factors that are important for implementing digital projects, and which allows for the peculiarities of their implementation. The paper also presents the sequence of stages for identifying priority areas of adaptation based on matrix sets and the development of necessary measures for the formation of the target level of the innovation potential and outlines a methodology that allows identifying key factors and determining the degree of influence for each of them. Based on the developed methodology, the most significant areas of adaptation of the digital innovation potential of the oil and gas industry enterprise in implementing the project for the introduction of virtual and augmented reality technologies were identified.

It should be noted that the mechanism of adaptation of digital innovation potential should not be considered in isolation but in the system of flexible management of innovation activities, which includes a number of other tools based on the principles of flexibility and adaptability. The complex nature of these tools will ensure the implementation of a flexible approach in the management of digital innovation projects characterised by a high level of uncertainty. The conclusions and recommendations of this study can be used by enterprises in forming a system of flexible management of digital innovation projects in various areas.

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