ORIGINAL PAPER

DOI: 10.26794/2220-6469-2021-15-1-14-27
UDC 338.364.4(045)
JEL A1

Risk Management as a Key Element in the Digital Transformation of an Industrial Enterprise

D.S. Pashchenko[a], N.M. Komarov[b]
[a] Independent consultant of software development, Moscow, Russia;
[b] CNII Center, Moscow, Russia
[a] http://orcid.org/0000-0001-9089-8173; [b] http://orcid.org/0000-0002-2431-6195

ABSTRACT

The Russian industry is entering digital transformation with some delay, and the implementation of accompanying large-scale changes contains a significant number of specific risks. Creating a promising business model and the technological outline of an industrial enterprise that implements it takes place under conditions of high uncertainty. The article proposes a general approach and elements of a practical risk model for planning and carrying out an industrial enterprise's digital transformation to reduce the uncertainty of the process in its significant aspects. The proposed management solutions help reduce the likelihood of a negative impact of accompanying general and specific risks, build a formalized model of risk management, and increase transparency in managing relevant practical projects. The article also discusses financial reserves usage as a tool for active risk management.

Keywords: risk management; financial management; digital transformation; change management; financial reserves

For citation: **Pashchenko D.S., Komarov N.M. Risk management as a key element in the digital transformation of an industrial enterprise. *Mir novoi ekonomiki = The World of New Economy*. 2021;15(1):14-27. DOI: 10.26794/2220-6469-2021-15-1-14-27**

INTRODUCTION AND PROBLEM STATEMENT

Practical implementation of the digital transformation of the industrial enterprise covers all phases of strategic management: from business planning to long–term development programmes monitored at the operational level [1]. Risk management in digital transformation is complex because it involves a variety of factors: from high levels of environmental uncertainty and variability to the need for specialized knowledge of applied technologies (necessary investments, end–to–end efficiency) [2]. It should be noted, however, that there are several hierarchical levels of risk management: on the one hand, there is a need to manage strategic risks at the enterprise level (group of companies), and on the other hand each project application requires its own operating procedures.

The main challenge addressed in this article is to reduce uncertainty in business planning and the digital transformation of an industrial enterprise and to find adequate methods to manage a variety of risks. The proposed risk models address the management of a variety of risks: both internal (primarily organizational resistance) and external environmental resistance. The typical algorithm for the digital transformation of an industrial enterprise, presented below, involves risk management at all stages — from targeting and assessment of enterprise readiness for digitization to operational risk management models in project applications. The relevance of this issue is linked to the insufficient level of development of digital transformation in industry, both in theory and in practice. It should be assumed that as the number of

successful long–term digitization programmes in industrial enterprises grows, the importance of risk management in formalized management processes will increase.

KEY ELEMENTS OF A DIGITAL TRANSFORMATION ORGANIZATION IN AN INDUSTRIAL ENTERPRISE

In assessing an organization's development prospects, balancing objectives and benefits with costs and risks is always important. This correlation is reasonably performed in the form of full–fledged business planning at the strategic level. Such planning as part of strategic and tactical management has a set of key elements that need to be understood in the preparation and adoption of management decisions.

A strategy — is essentially an extended business plan for a company based on a variety of models of its current and prospective work. However, it is not the starting point in development management, but rather documents the necessary steps and resources to fulfil the mission and vision of the company. The following figure shows a typical 4 –level corporate governance structure: from the company's mission to the implementation of operational management. *Fig. 1* also provides a vision of the place of strategy and long–term business planning in such a structure.

Thus, a company–wide risk management model is an essential element of corporate governance. Risk management towards the digitization of an industrial enterprise is an integral part of such a model.

Considering the processes of digital transformation as the most efficient (yet costly) way to implement long–term enterprise development plans and to gain unique competitive advantages, the following key elements should be identified:

1. **Transformation method and algorithm.**
2. **Economic modelling of the course and results of transformation.**
3. **Risk Model.**

Consider these elements, focusing on the analysis of the structural links between them. This focus allows to understand the role of risk management at each stage of planning and implementing a digital transformation. For example, certainly, risk management is part of active business planning at the strategic level, and therefore the establishment of a regular monitoring and risk management process should go hand in hand with the start of the business planning and strategic targeting cycle. When a process approach is applied, risk is identified "the processes of developing and implementing strategic plans, the quality of which primarily determines the balance and realism of the strategic plan, as well as the level of risk of hidden errors" [3]. Part of the current risk–management model is the prevention of substitution in purpose and the consistent maintenance of focus in the strategic planning of digital transformation on economic parameters — growth of company value, increase of profit and turnover, reduction of production costs, etc. The strategic risk management model aims to "minimizing the likelihood of failure to achieve the goals and objectives, as well as minimizing the probability of loss of part of income and capital, customer base, market niche, slowdown or loss of reputation of an industrial enterprise" [3]. Thus, the first significant part of the risk model — are the risk groups directly related to targeting and planning digital transformation as an effective method of achieving the long–term business plan targets.

On the other hand, the introduction of large–scale changes accompanying the digital transformation contains significant uncertainties in economic parameters: from assumptions at the time of initial budgeting to multiple cost increases due to delays in implementing digitization programmes. According to a number of researchers, much of this potential cost is related to organizational resistance, leading to possible loss of staff

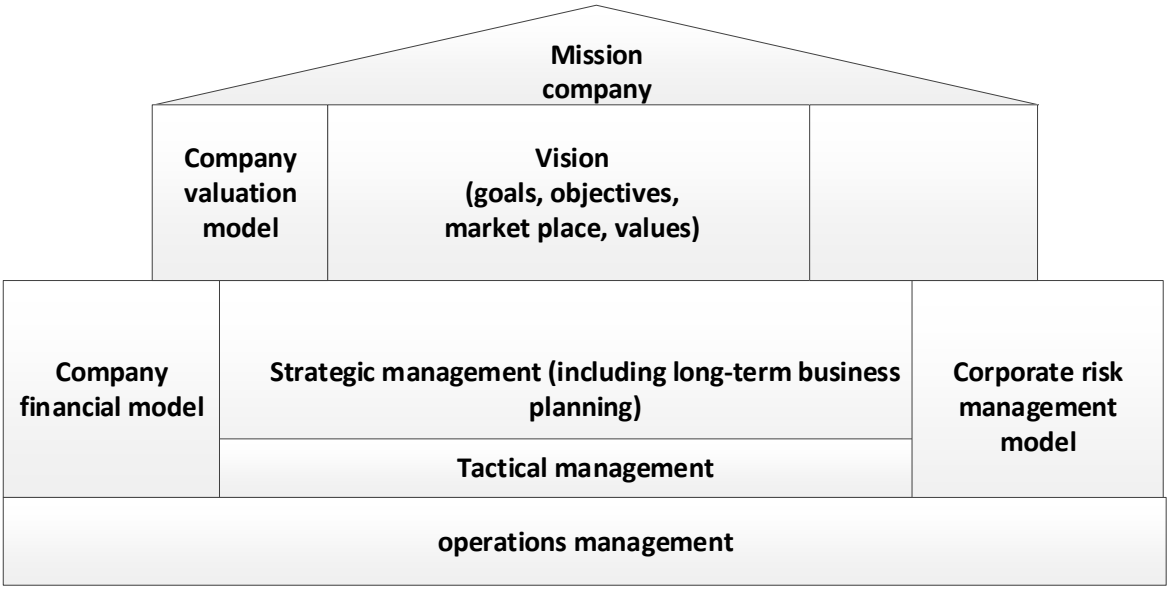

Fig. 1. **The structure of modern corporate governance**

Source: the authors.

productivity, delayed delivery of tasks and even sabotage of changes [4, 5]. Equally important is the variability of the external environment: technologies, consumer expectations, the actions of regulators that also influence the evolution of an industrial enterprise. Risk management, however, affects the operational, tactical and strategic levels of governance, meaning that understanding of its role in digital transformation must be achieved early in the planning of change.

The complexity of economic analysis of digital transformation also entails a high degree of uncertainty in both budgeting and return–on–investment models. Both the estimation of the programme budget of projects and the estimation of the potential growth of economic indicators need to be compared by case studies that simply do not exist in Russian practice. In addition to internal and external resistance to change already noted, a key feature of economic modelling in digitization is the increasing uncertainty of the competitive environment. These include the acceleration and desynchronization of cycles of changes in the influence of competitive forces — supplier capabilities, level of demand and consumer power, level of competition in each market, changes in accessibility and opportunities for innovative change methodologies. Thus, creating a sustainable economic model of digital transformation also needs active risk management. Timely risk management reduces the level of uncertainty in the estimation of the total transformation budget as an investment element that fulfils the key innovation function [6]. On the other hand, the complexity of return–on–investment models, which is consistent with real competition, also needs to be analysed and actively managed in relation to significant risks. Finally, risk management and modern financial management practices imply the creation of a system of financial reserves — sufficient to mitigate the negative impact of realized risks and liquidity to reconcile such reserves with the financial policies of the enterprise. Another key feature is that the boundaries of digital transformation are fluid, and the effectiveness of applied technologies is not deterred, which means that the "flexibility" in managing risks and associated financial reserves must be maintained.

Finally, taking an even broader view of the problem, it should be noted that effective

management of the risks of timely change — is a competitive advantage and a new competitive force in much of the "new economy" [7]. This is also true for knowledge–intensive industrial activities that generate high value–added products with low resource dependency (e.g., organic raw materials, metals, energy). Thus, the risk model itself is also a key element in the organization of digital transformation. This element involves both significant preparatory work (risk identification and ranking), and continuous monitoring of the probabilities of realization of risks and the application of appropriate management plans (mitigation, emergency). As stated earlier, risk management towards digital transformation should be part of a corporate risk model.

Consider these key elements of planning and implementing the digital transformation of the industrial enterprise in more detail, focusing the analysis on the significant role of risk–management.

TYPICAL ALGORITHMS FOR ECONOMIC MODELLING AND PRACTICAL IMPLEMENTATION OF DIGITIZATION

A typical method of planning and organizing digitization sees it as a way of achieving the strategic goals of an organization based on a promising business model of an enterprise and providing its technological contours. In summarizing the Russian experience of large industrial groups, it is important to note the need to formalize the organization of transformation in a separate document, often as an integral part of the strategy. Realization of long–term goals involves creation of technological contours by execution of projects programs in business and technological directions, automation objects (factories, production complexes), echnological stacks within contour. For example, the "Rosatom" corporation began its digital transformation in mid-2017 with the development of a detailed the Digital Single Strategy (DCC) document, which in 2020 contains ideas about the transformation of 10 industrial divisions into the structure of "Rosatom" [8]. The implementation of DCC required the consolidation of seven corporate units into a special digital unit, which conducts dozens of projects on the introduction of promising technologies within the framework of a common vision.

Economic modelling of the costs, financing and return on investment in a digital environment is a justification not only for the respective project programmes but also for the corporate development strategy as a whole. In the corporate governance framework presented in *fig. 1*, such data form part of the financial model of a company and determine the long–term growth of its valueThe calculation of transformation budgeting is based on project programmes, in accordance with the composition of the technological framework being implemented and taking into account the necessary financial reserves to eliminate the negative effects of realized risks. Funding model is mixed: other than related financial flows, to programme projects should be funded for special organizational unit, which management of digitization at the corporate level. Also included in the funding model are components related to the "flexible" management of financial reserves [9] — creation of reserves, transfer of funds from reserves to operational management, control of expenditure of reserves, etc.

Digital Transformation Return Model is a key issue in both its planning and in the summing up of each iteration. This model is based on economic targets identified in the course of business planning and agreement on the final version of the strategy: turnover and profit of the enterprise, cost of production, speed of production of a unit of a good, etc. Whether or not an enterprise achieves a return on investment model in practice determines not only the success of the

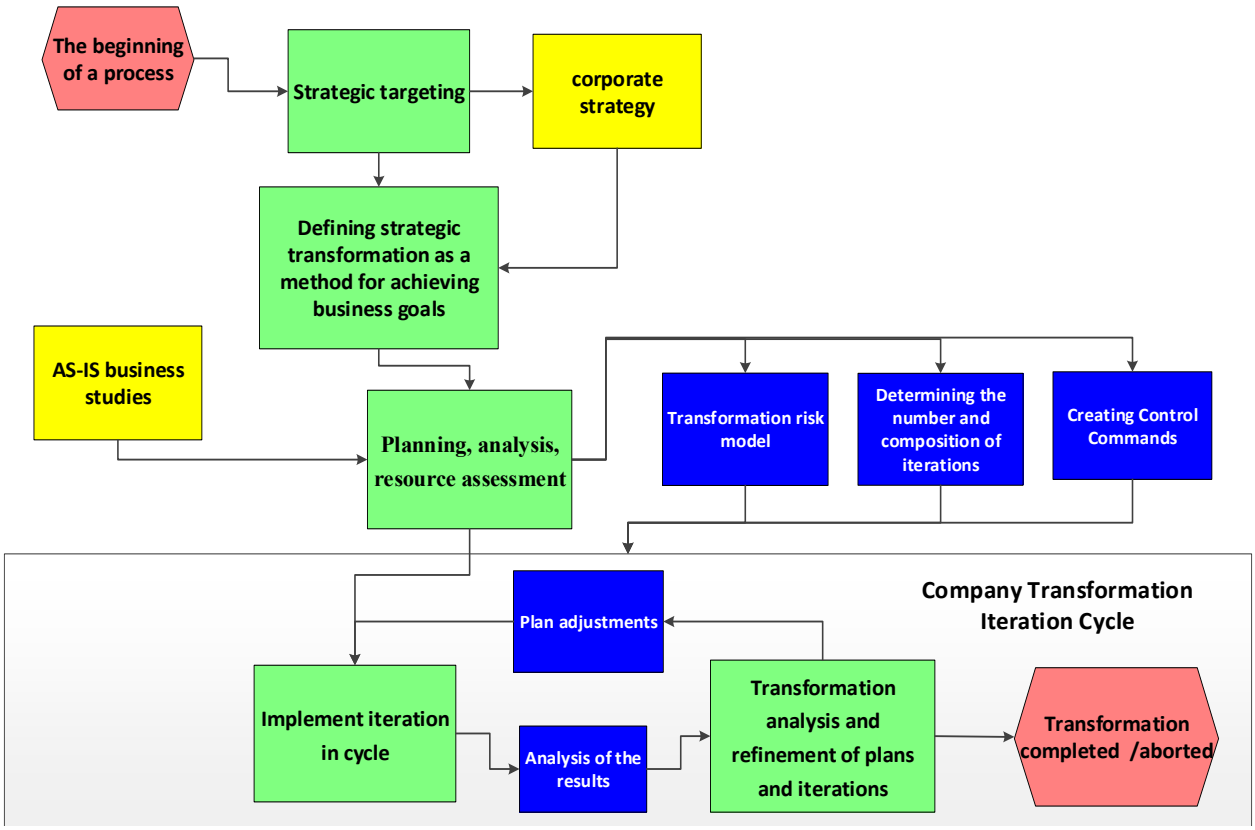

Fig. 2. **A typical algorithm for the digital transformation of an industrial enterprise**

Source: the authors.

investment already made, but also seriously influences the readiness of the company's top management to continue to digitize and develop the target business model and the corresponding technological contour [10]. The risks associated with an enterprise's economy during digitization form another important group requiring active management.

Implementing strategic transformation (and not just planning, analysing and assessing costs and risks) — it's the toughest issue in modern strategic management [11]. It requires in–depth analysis at all levels of activity, a combination of process and project approaches, substantial investment, knowledge and readiness of top managers and enterprise owners. The most logical option is to develop a road map for strategic transformation that includes not only processes for targeting but also the choice of methods for implementing change, monitoring progress and evaluating its cost–effectiveness. By default, the road map consists of a set of steps presented in *fig. 2*. It should be noted that the scale of the business and the industry impose substantial conditions on the preparation and implementation of such a road map.

Of course, taking the need for strategic business planning as an initial phase in the formulation of objectives and success criteria, the following practical stages of industrial enterprise transformation should be briefly considered. Implementing large–scale changes in an industrial enterprise within a digital transformation can be simplified into four phases:

1. Enterprise readiness assessment ("AS–IS") by categories: finance, technology, human capital, management competencies;
2. Modelling forward–looking development ("TO–BE") related to value chain renewal in

client–centred, extended product life cycle and evidence–based decision–making;

3. Creation of technological contours, teams of specialists and bases of applied knowledge, implementing a forward–looking development model;

4. Iterative launching of elements of the future development model: by products, geographical locations, elements of value chains.

Despite the late start of the digital transformation in Russian industry and the possibility of benchmarking this process (including using external consulting and experience from completed projects of global corporations), the dynamics of the introduction of individual technologies in Russian industry are contradictory. The market of Russian suppliers of IT–solutions from the concept of "Industry 4.0" for industry is rather limited, and the vast majority of Russian solutions depend on hardware produced abroad.

The set of ready/unprepared status of an industrial enterprise for digital transformation forms a significant part of the model of its current activity — "AS–IS". Next, the modelling of future development related to value chain upgrading should start. This "TO–BE" target model is the next step in the digital transformation and includes:

1. Prospective economic performance sought by an industrial enterprise cascaded from the level of enterprise strategy.

2. Model of business and production process to be started and implemented.

3. Methods, objectives, specific objectives and transformation plan, taking into account specific and general sectoral risks and influences.

Among the influencing factors is the need to place the client at the centre of the industrial enterprise's efforts and to support the extended product life cycle (ideally — for each item and for the product as a whole).

It is very useful to rely on the methodology of the digital economy to create forward–looking models. This is how banks and financial institutions have been digitally transformed: famous concepts "Bank 2.0/3.0/4.0", "Bank as IT–company", "Omni –chanell self–help for clients" and others allowed each organization to see the final milestones in digitization. In industry, similar concepts are found at the very beginning of development, for example the "autonomous robotic plants Industry 4.0". The most complete concept in 2020 (in the technological part) — is the creation of reference models of objects by branches of industry: "digital factory", "digital drilling tower", "digital logistics chain". The concepts of such models are now well advanced, but the development (and, more precisely, the cost) of appropriate technologies does not yet allow such concepts to be considered fully optimal. An example of a transformation already implemented according to the reference model — is the Mercedes–Benz Factory 56 in Zindelfingen[1]. It is probably — one of the most autonomous and robotic industries today, realizing significant competitive advantages of digitization.

The next stage in preparation of the digital transformation of the industrial enterprise is creation of technological contours, teams of specialists and bases of applied knowledge, implementing the approved forward–looking development model.

Process or production contours — are the sum of the various technologies that provide the production function,— from planning to launching and performance analysis. The contour needs to take into account information, production and management technologies that enable research, design, production, marketing, service, industrial recycling. Of course, the choice of technologies to be integrated depends

[1] Official opening of Factory 56. Official Report. URL: https://www.mercedes-benz.com/en/innovation/connected/official-opening-of-factory-56/.

on the long–term development model and the goals chosen in the previous phase. In addition, the first experience of the efficiency of particular technologies by industry and specific production functions is now available. On the other hand, such a contour is an integral part of the "TO–BE" model, and its design is complicated by the facts of readiness/unpreparedness of production of enterprises and technologies to each other. This complication should be reflected in the planning of transformation iterations and risk management.

A non–exhaustive list of most successful technologies and applications in industry should be provided (*table 1*). These technologies are generally grouped into logical groups (clusters) and form the contour of the digital transformation. As can be seen from the *table 1*, quite often the use of a certain technology means that "neighboring" innovations have to be mastered. This is due to the already existing experience with technology adoption in industry and the emphasis on the economic benefits of innovation.

The creation of the technological contours of digital transformation in a specific industrial enterprise has a set of constraints:

- device and software technology readiness without major modification to achieve transformation goals;
- staff readiness of the enterprise's employees to realize transformation goals with this technological contour.

Of course, in the course of transformation, because of the speed with which the technologies themselves change and the expectations of their adoption, significant changes in the composition of the production contour can be made, but splitting into iterations in digitization makes such changes smoother and associated with specific tasks and goals. The introduction of innovative technologies into relevant project programmes implies active risk management and forms another important group of risks.

Equally important at this stage is to form teams of specialists whose efforts will be directed to detailed planning and implementation of changes. The competence and authority of a formal business–unit responsible for the entire transformation of an enterprise may not be sufficient in complex nodes: integration, technological expertise and introduction of changes directly in workshops, geographically distributed production facilities and remote facilities. It is equally important to manage organizational resistance in the workplace: automation, robotization and any other innovation are always surrounded by fears of job losses, areas of responsibility in production and the power of line managers [4, 12]. The associated risks form another group related to the internal organization of the digital transformation.

From this stage onwards, the development of knowledge bases should not be neglected. Practice shows that digital transformation is spread out over years and in large companies is unevenly distributed across production and over time. Accumulation of best practices and experience in dealing with new technologies, accounting for errors and analysis of results should be recorded in knowledge bases [13]. The distribution of experience makes it possible to avoid the repetition of typical risks, to reduce the labour cost of introducing changes, to accelerate the scale of already introduced innovations to other markets, products etc.

Finally, the last part of the process — is the iterative launching of elements of a forward–looking development model. As shown above, virtually every enterprise creates its own unique contours related to the specific geography and technology of production, consumer expectations, competitive pressures and the amount of planned spending on key resources.

The most important role of risk management in digital transformation is precisely at this last stage — direct iterative implementation of change. Typical risks include those already

Table 1

Using applied technology clusters

No.	Technology	Project applications and examples
1	Internet of things, including digital logistics and IT — solutions like SCADA	Interaction of machines and mechanisms between itself — system of accounting of electric power in corporation "Rosseti". Data collection on processes and facilities — "Inter RAO — Electrogeneration" — data collection and processing from power plant facilities.
2	Specialized mobile software and hardware systems	Data collection at the sites — monitoring of repair and maintenance at the Smolensk NPP. Equipment Parameter Control — Samara Oblast Bezymyanskaya Thermal Power Station.
3	Artificial intelligence, including neural networks, predictive and expert models, computer vision	Analysis and synthesis of data — system of analysis of samples of aviation fuel in "Gazpromneft–Aero". Expert and recommendatory decisions — service to speed up operation of hot rolling mill in NMLK.
4	Industrial robots	Production functions — production of agricultural machinery in the company "Promparts". Auxiliary functions — supplying of blanks in production of brass products in the company Brassko (Orenburg). Transport functions — transport of cargo inside the warehouse at the Moscow refinery.
5	Virtualization of processes and objects, including "digital doubles"	Design and production processes — simulation of geological works in difficult oil production — Kiber GRP 2.0 in Gazpromneft, simulation of car crash tests in "AvtoVAZ". Other business processes — "digital double" processes of optimization of procurement activities and management of external road transport logistics in Severstal.
6	Big data processing	Advisory and expert solutions — advice on optimum ferroalloy consumption in steel production in NLMK.

Source: the authors.

described: financial (transformation finance), market changes (affecting strategic targeting), and organizational resistance. The specific risks associated with this last phase should also be highlighted:

1. Finding the right way to innovate in extended product life cycles.

2. Complex coordination of modernized elements of value chains of production during digital transformation to avoid "bottle neck" of innovation.

Both risks are closely related to the environment in which the enterprise operates and form another significant group — almost every element is to some extent related to external parties, regulators, and current customers.

THE ROLE OF ACTIVE RISK MANAGEMENT IN DIGITAL TRANSFORMATION

Note that the risk model is also an essential element in the planning and implementation of the digital transformation of an industrial enterprise. Risk management covers all stages of the process and aims at a consistent reduction of uncertainties. Some risk groups have been identified in the past and their generalization seems to be universal for most digital transformations in the industry:

- risks related to targeting and business planning;
- financial and economic risks;
- risks related to the external environment of the enterprise;

• technological risks within the chosen contour;
• risks associated with the organization of large–scale changes.

Consider a general approach to risk management in the digital enterprise. Thus, strategic planning in this context involves two sets of work:

• formalization and assessment of risks, development of management plans and allocation of reserves for risk management;
• determining the impact of the risk reserve on the budgeting and financing of the digital transformation (both at the planning stage and in future budget execution).

Initial formalisation and risk assessment shall be carried out by the method described in [3], shall cover the full first group of risks and shall include the following steps:

1. Identification of factors that make it difficult to define the organization's strategic goals within the framework of digital transformation;
2. Ranking of factors according to two parameters: level of destructive effects and probability of realization of risk;
3. Development of management plans: measures and organizational arrangements to limit the impact and reduce the likelihood that the identified factors will be met;
4. Carrying out a balanced analysis of the developed business plan of digital transformation and presenting its results to the company's top management.

It should be noted that this group of work includes a focus on risk management in the process of strategic digital transformation planning, namely: the division of strategy development functions and the final analysis (expertise) function into errors between different, independent groups of specialists in the company.

The use of financial reserves in risk management is equally important. On the one hand, the spending of financial reserves — is a natural response to the realization of risk, not to slow down the pace of change, not to change goals, not to accept additional iterations. On the other hand, earmarking has an impact on overall budgeting processes — it is not simply the imposition of additional ratios on objects of expenditure. First of all, it is the construction of a complex system of liquidity reserves, which are introduced "into battle" on the formalised process.

Risk management continues to be implemented during the creation of the business plan through detailed identification, classification and prioritization. As the outcome document should be proposed a risk, normally containing:

1. Group and risk name.
2. Priority.
3. Reserves and/or damage assessment when the risk is realized (usually a figure or function from time to time).

As we move forward on the transformation road map (*fig. 1*), as we study the enterprise's readiness for digitization (within the framework of the "AS–IS" model), and as we prepare the future business development model ("TO–BE"), the identification of risks reveals more and more types of risks, which must be analyzed using the algorithm already specified above. Thus, it is possible to group risks according to different unifying characteristics, such as belonging to a particular system, according to the objects of damage, by the nature of the risk, etc. In the case of default digital transformation project programs, the following list can be proposed that expands the previously identified risk groups:

• inclusiveness of business strategy;
• financial and economic risks;
• technological risks;
• risks of a competitive environment;
• organizational risks, including the operation of change management teams and the need to overcome team resistance in a group of companies.

Table 2

Sample part of a digital transformation risk plan

No.	Risk profile for "organizational risks"	Response plan	Emergency plan
..	...	...	...
1.5	Possible non-implementation of changes in Department A. Declaratory motive — backlog in their own projects. The real motive is the resistance of the head of department A	Avoid risk. Involve the head of department and the whole team to interact. Learn more about the personal motivation of project team members to resist	Engage top management of the company. Include the head of the department in the change management team Financial reserves — 5000 USD
1.6	Difficulty of involving khabarovsk branch employees in the management of changes (geographical distance, time difference)	Attract the most active staff of the branch in the format of one-day sessions. Use remote communication channels for regular meetings. Financial reserves — 500 USD	Organize travel to the branch at key points of iteration with discussion of intermediate results and feedback Financial reserves — 2000 USD

Source: the authors.

Depending on the industry and the details of the digital transformation, it is also possible to separate groups for regulatory, environmental, social risks.

The next step — is to prioritize and rank risks within the group. It is clear that the higher the probability of realization of the risk and the associated potential damage, the higher the risk in the ranking. The definition of potential harm can be computed as a simple product of the probability of realizing risk (in %) by the amount of damage to business (maximum, expected, minimal in risk management). In more complex risk management models, damage can be defined as a function from time to time, such an approach shows daily losses while ignoring the resulting risk.

The risk register should then be supplemented by appropriate management elements:

1. Response (Mitigation) Plan
2. Emergency plan.
3. Reserves.

For each risk, it is necessary to formalize a risk response plan — a set of organizational measures to reduce the potential damage and/or the likelihood that the risk will be realized. As a general rule, a response plan involves formalizing the necessary minor cash outlays provided for in the respective reserves. Virtually every response (mitigation) plan contains reasonable signs of success/failure, expressed in terms of timing, financial loss or other parameters. Such criteria govern the need to move to an emergency plan, which also needs to be prepared in advance for high–priority risks. Emergency plans — are management actions aimed at minimizing the already real and significant damage to the business after the risk has been realized. In the case of a digital transformation with significant investments,— significant liquidity reserves should be available for such risks, which will be spent during the implementation of the emergency plan to support the set rate (schedule, teams, effort) of the enterprise's digitization. A typical template for the risk register, combining the above information, is shown in *table 2*.

It follows from the authors' personal practice that some universal risks related to the groups already described in the general risk register need to be identified. For the group related to the very possibilities of agreeing on and implementing a business strategy, it is necessary to highlight:

- Insufficient level of expertise among the enterprise managers in determining the time and scope of business planning tasks;

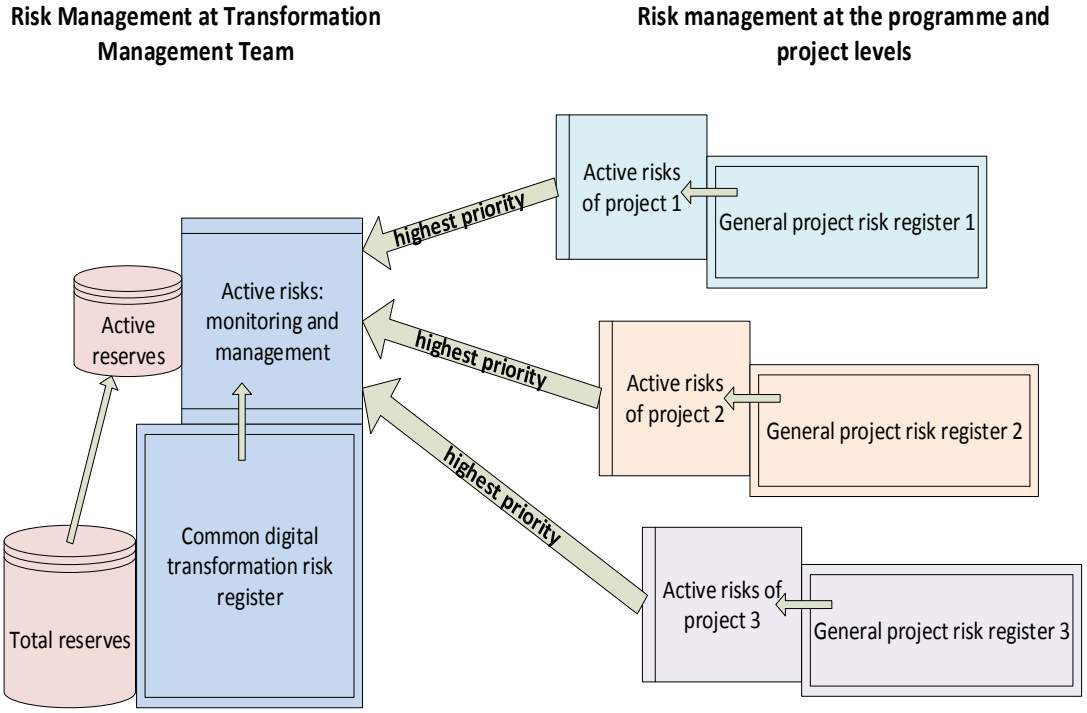

Fig. 3. **Operational and tactical risk management model**

Source: the authors.

• unjustified cost savings in key areas of digital transformation built into initial planning;

• Establishment of formal numerical benchmarks that do not reveal the economic essence of successful transformation of production and technological processes.

Among the risks in the group of financial and economic aspects of transformation, attention should be paid to:

• the need for continuity and synchronization of financing of technology project programmes;

• a low level of attention to the investment return model being created and agreed upon (realism, consistency in achievement, connection with the enterprise's promising business model);

• a low level of attention to the economic results of each digital transformation iteration (investment accounting, performance, parameters, etc.).

Among the most universal technological risks:

• the need to analyse the dynamics of changes in the basic parameters of innovative technologies, including their cost, technological maturity, market availability, etc.;

• difficulties in integrating innovative technologies among themselves and into the current IT — landscape of the enterprise;

• the capabilities of the enterprise's own engineering teams in the practical use and maintenance of technologies in production and business processes.

It should also be noted that the most common competitive environmental risks affecting the planning and implementation of the digital transformation of an industrial enterprise are:

• taking into account the pressures of the competitive environment, including an analysis of the methods used and the speed at which the closest competitors achieve the same economic performance;

• changing the expectations of consumers, counterparties, investors associated with the

products, services and business processes of the enterprise;

• changes in the regulation of industries by State bodies, including foreign and international organizations.

The cross–cutting and frequent threats from the organizational risk group are presented as follows:

• spontaneous introduction of large–scale changes without clear planning, automation and informing of staff;

• the emergence and spread of serious organizational resistance;

• "piecemeal" implementation of changes with numerous backsliding and existence of parallel and duplicative business processes.

Thus, in moving from business planning and targeting to implementation, the boundaries of identifying and prioritizing risks across project programmes and technology areas are significantly expanded (elements of the technological contours implementing a promising business model). Each project programme receives its own risk register with response and mitigation plans. Part of the risks in such private registries are cascaded from the overall corporate level.

The next step in actively managing the risks of digital transformation is continuous monitoring and controlling. The most convenient way to do this is to synchronize the management of current risks across project programmes while simultaneously managing the most fundamental risks of digitization. This approach maintains a balance between centralized management of reserves and distributed scenarios of response (mitigation) and contingency plans for groups and even individual risks.

Such risk management in a digital transformation is conveniently constructed on the basis of a hierarchical model of linked lists of different levels of operational relevance. The general features of this model are presented in *fig. 3*.

The most damaging and topical risks for transformation iteration are in mixed management: the implementation of mitigation plans and emergency plans lies in a joint area of responsibility for the digital transformation management team and individual project (project's program) managers. The allocation of financial reserves to such risks is centralized. Current risks with lower priority are managed separately: overall corporate risks are handled by a dedicated unit responsible at the corporate level for digital transformation, while private project risks are handled by the respective project managers.

The iterative nature of the digital transformation allows a more gradual and balanced consideration of the impact of risks, combined with the analysis of intermediate results [14]. The identified and significant risk pressure on the resulting economic results is a significant factor both in the re–focus of digitization in the next iteration, and adjusting the strategic goals of the organization, the forward–looking business model and the composition of the technological contours. Regular reassessment of financial reserves within risk management [9, 15], implying a "flexible" allocation of reserves in current areas of digitization, is also a good practice. Practical experience of digital transformation, determined by the characteristics of the corporate culture of each industrial enterprise and the set of technology stacks in the contour, over time, optimizes both the financial reservation model and the rate at which cash is injected/withdrawn from operations into reserves [16].

CONCLUSION

According to some researchers, the digital transformation of an enterprise — is almost a forced step, a kind of response to the competitive challenge of the external environment [17, 18]. For Russian industry,

digitization is already catching up, despite the Russian market's achievement of a sufficient level of maturity [10, 14, 19]. As shown in this article, a combination of general and specific risks accompanies the entire long–term process of digital transformation. Managing such risks should be part of the corporate risk management model and enable: identify threats and potential costs, prepare for negative consequences during realization of risks, and "flexibly" react to competitive challenges and objective complexities of implementation of large–scale changes.

The article proposes a set of current risk management models aimed at managing risks at all stages of a typical digital business transformation road map: from business planning to the introduction of elements of the technological contours of the prospective business model through application project programs. It is clear that such risk management should also cover all typical risk groups: from targeting to significant internal organizational resistance that rapidly devalues investments already made [20]. The proposed two–tier hierarchical model of risk monitoring allows to flexibly manage the efforts of teams implementing changes and financial reserves.

Moreover, financial reserves, as a method of operational response, remain relevant to all phases of risk management: from business planning and transformation budgeting to the end of implementation and embedding in practice large–scale changes in technological and business processes.

Regular identification, monitoring and controlling of risks certainly save money for the enterprise and increase transparency in complex digital transformation processes.

REFERENCES

1. Zub A.T. Strategic management: Theory and practice. Moscow: Aspekt Press; 2002. 415 p. (In Russ.).
2. Brichko S.S. Strategic risk management concept as an element of company development strategy. *Vestnik Irkutskogo gosudarstvennogo tekhnicheskogo universiteta = Proceedings of Irkutsk State Technical University*. 2013;(2):167–169. URL: https://cyberleninka.ru/article/n/kontseptsiya-strategicheskogo-risk-menedzhmenta-kak-element-strategii-razvitiya-kompanii (In Russ.).
3. Bukhtin M.A. Strategic risk management methods. *Upravlenie finansovymi riskami = Financial Risk Management Journal*. 2005;(3):12–26. (In Russ.).
4. Zankovskii A. Organizational psychology. Moscow: Flinta; 2002. 648 p. (In Russ.).
5. Pashchenko D.S. How software company engineers perceive changes in production. *Mir novoi ekonomiki = The World of New Economy*. 2015;(1):74–82. (In Russ.).
6. Veselovskii M. Ya., Izmailova M.A., eds. Acceleration of digitalization processes in Russian industry based on the development and effective use of innovative human capital. Moscow: Nauchnyi konsul'tant; 2020. 225 p. (In Russ.).
7. Komarov N.M., Pashchenko D.S. Modern hi-tech IT-company: Brief overview. *Vestnik Evraziiskoi nauki = The Eurasian Scientific Journal*. 2019;11(4):48. URL: https://esj.today/PDF/58SAVN 419.pdf (In Russ.).
8. Abakumov E.M. Digitization in ROSATOM State Corporation: Challenges to Industry 4.0. Presentation. URL: https://russoft.org/wp-content/uploads/2020/08/Prezentatsiya-Evgeniya-Abakumova.pdf (In Russ.).
9. Panyagina A.E. Reservation as a method of control over financial risks of the organization. *Aktual'nye problemy gumanitarnykh i estestvennykh nauk*. 2013;(1):114–119. URL: https://cyberleninka.ru/article/n/rezervirovanie-kak-metod-upravleniya-finansovymi-riskami-organizatsii-1 (In Russ.).
10. Lola I.S., Bakeev M.B. Digital transformation in the manufacturing industries in Russia: An analysis of the business tendencies observations results. *Vestnik Sankt-Peterburgskogo universiteta. Ekonomika = St Petersburg University Journal of Economic Studies (SUJES)*. 2019;35(4):628–657. (In Russ.). DOI: 10.21638/spbu05.2019.407

11. Shcherbakov D.S. Strategic transformation of an innovative enterprise in crisis. *Strategicheskie resheniya i risk-menedzhment = Strategic Decisions and Risk Management*. 2011;(4):58–67. (In Russ.).
12. Piskunov A.I. Challenges, threats, and expectations of digitalization for industrial enterprises. *Organizator proizvodstva = Organizer of Production*. 2019;27(2):7–15. (In Russ.). DOI: 10.25987/VSTU.2019.33.81.001
13. Akatkin Yu.M., Yasinovskaya E.D. Digital transformation of public administration. Datacentricity and semantic interoperability. Preprint. Moscow: DPK Press; 2018. 48 p. URL: https://www.rea.ru/ru/news/SiteAssets/prepint-monografii.pdf (In Russ.).
14. Pashchenko D.S. Management of production changes in a high-tech company. Kazan: Buk; 2019. 100 p. (In Russ.).
15. Avdoshin S.M., Pesotskaya E. Yu. Business informatization. Management of risks. Moscow: DMK Press; 2011. 176 p. (In Russ.).
16. Sheremet A.D., Kozel'tseva E.A. Financial analysis. Moscow: Faculty of Economics, Lomonosov Moscow State University; 2020. 200 p. (In Russ.).
17. Garifullin B.M., Zyabrikov V.V. Digital transformation of business: Models and algorithms. *Kreativnaya ekonomika = Journal of Creative Economy*. 2018;12(9):1345–1358. (In Russ.). DOI: 10.18334/ce.12.9.39332
18. Rudnitskii G. Digital transformation: Not ideal, but a necessity. IT World. Mar. 07, 2019. URL: https://www.it-world.ru/cionews/management/144082.html (In Russ.).
19. Knyaginin V.N., Idrisov G.I. et al. New technological revolution: Challenges and opportunities for Russia. Expert and analytical report. Moscow: Center for Strategic Research; 2017. 136 p. URL: https://www.csr.ru/uploads/2017/10/novaya-tehnologicheskaya-revolutsiya-2017–10–13.pdf (In Russ.).
20. Freilinger C., Fischer J. Geht nicht — Geht nicht!: Veränderungen erfolgreich managen. Linz: Trauner Verlag; 2001. 284 p. (Russ. ed.: Freilinger C., Fischer J. Upravlenie izmeneniyami v organizatsii. Kak uspeshno provesti preobrazovaniya. Moscow: Knigopisnaya palata; 2002. 264 p. URL: https://ru.calameo.com/read/0030497503cb8d94ea1b4).

ABOUT THE AUTHORS

Denis S. Pashchenko — Cand. Sci. (Engineering), independent consultant of software development, Moscow, Russia
denpas@rambler.ru

Nikolay M. Komarov — Doctor of Economics, Professor, Scientific consultant, Federal State Unitary Enterprise "Central Research Institute "CENTER", Moscow, Russia
nikolai_komarov@mail.ru

The article was received on 30.12.2020; revised on 15.01.2021 and accepted for publication on 22.01.2021. The authors read and approved the final version of the manuscript.