Strategic determinants of industrial enterprises’ technological development

Abstract. The pace of technological changes requires certain flexibility of industrial enterprises’ business models. The paper aims to uncover and explore the importance and interaction of the determinants of technological development strategies. Methodological basis of the research rests on the tripod strategy perspective and the theory of technological development. The authors apply general scientific and sociometric methods, regression analysis. The research builds on the answers of 148 respondents that include executives and specialists of mechanical engineering enterprises, as well as experts from the Union of Defence Industry Enterprises of the Sverdlovsk oblast, regional branches of OOO “Russian Engineering Union” in Sverdlovsk and Chelyabinsk oblasts. The survey results allow determining the composition of the institutional, sectoral, and resource determinants of technological development strategies, of which the most influential is the institutional determinant. Technological turbulence, if inherent in the sector, decreases companies’ capabilities to respond to the institutional pressure. The most important component of the resource determinant is the availability of funds for investment, which eliminates the problems of attracting qualified personnel, protecting intellectual property, and increasing the speed of production technologies development. The research findings may be of use for company executives to formulate a balanced technological development strategy as well as for government authorities while providing state support.

Keywords: tripod strategy perspective; technological development; industrial enterprise; institutional pressure; technological turbulence.

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Introduction

Technological changes associated with the development of computer systems and digital technologies such as artificial intelligence, machine learning, blockchain, cloud computing, the Internet of things, etc., along with the globalisation of the economy and saturation of markets, have a huge impact on modern business. As a result, completely new economic and technological trends are emerging, shaping the image of the modern intelligent digital enterprise. In the digital economy, when the business model of an industrial enterprise is focused on organising the production process and interacting with customers in a digital environment using digital technologies, it is no longer enough simply to automate processes, technologies are expected to be more advanced.

Increasing the competitiveness of business is a key strategic objective of any enterprise, since it determines the possibilities of its economic growth. The efficient way to reach this objective in the digital economy directly depends on the level of technological development, by which we mean the update and modernisation of technical means, production technologies, machinery and other production equipment by widespread introduction of new intelligent production technologies. Taking into account the above, the issues of developing an effective technological strategy of an enterprise is of special relevance today.

The key objective of this strategy is to ensure sustainable competitive advantages. Scientific approaches, which have been developed since the middle of the 20th century, explain the origin of a company’s competitive advantages in different ways. Proponents of the process approach and resource-based view focus on its internal environment, pointing out that the sustainability of competitive advantages is due to its actions and organisational mechanisms, the presence of a portfolio of hard-to-copy resources, and the ability to reconfigure resources in response to changes in external conditions. Attention to the external environment is characteristic of sectoral and relational approaches [Orekhova, 2017b]. Depending on the approach, strategic management focuses on the relevant aspects of a company.

A serious constraint of these approaches is neglecting the institutional environment conditions. Even in the works of Oliver it was pointed out that “institutions are more than background conditions” [Oliver, 1991, p. 171]. Khachaturyan noted that the most important factors in the sustainable development of an enterprise’s competitive advantages are competitive security due to its hard-to-copy resource combinations and harmony with the environment as a result of constant synchronisation of its strategy with external conditions [Khachaturyan, 2007]. Orekhova substantiated that the resources of an enterprise and its institutional environment are two factors equal in importance and mutual influence [Orekhova, 2017a].
Criticism of the resource-based view and sectoral approach to a company’s strategy for insufficient attention to the institutional context led to the emergence of a separate research area, where there were some attempts made to integrate the provisions of the three considered approaches into a single concept (cf.: [Oliver, 1997; Shirokova, Sokolova, 2013; Lazzarini, 2015]). Researchers devoted a number of works to the creation of the concept of the tripod strategy perspective (for a review see: [Peng et al., 2009]), which substantiates the strategic choice of an enterprise because of its dynamic interaction with the institutional environment. Based on empirical data obtained from expert surveys, the authors showed the importance of the mutual influence of institutional and industry factors for a company to choose a strategy for managing its resources [Gao et al., 2010]. Later, Peng theoretically proved the equivalence of environmental institutions and the ability to manage resources as the basic factors that determine a company’s strategy [Zoogan, Peng, Woldu, 2015].

As for the technological development strategy of an enterprise, we have the same prerequisite – it is determined by factors of a resource, sectoral and institutional nature. In other words, the content of the strategy is likely to be determined by the level of development of the production and technological base of an enterprise itself, the dynamics and nature of technological changes in the industrial market, as well as the parameters of the institutional environment that sets the directions, opportunities and constraints of the technological development of industries and the national economy as a whole.

At the same time, the factors that have a determining influence on the content of a company’s technological development strategy have not been studied thoroughly. Most scientists concentrate on the evidence of the influence of sectoral, resource and institutional factors on the strategy and on each other, without detailing what they consist of and what specific conditions (we called them components) make up the factors under study.

The purpose of the study is to identify the most significant conditions that determine the technological development strategy of an industrial enterprise. We differentiated the identified factors in accordance with the theoretical provisions of the tripod strategy perspective, i.e. we classified them as sectoral, resource and institutional. Firstly, this made it possible to verify the validity of the chosen theoretical framework of the study, and secondly, to find confirmation that the mutual influence of factors, if any, is significant.

In this context, government regulation should be considered as an external factor of the third level, which determines the development of individual production ecosystems through regulation of the intensity of the above factors or the direct
implementation of changes in specific production companies that use government support measures.

Factors such as scientific and technological progress, division of labor, economic integration and cooperation, uneven economic development of regions, etc., have a direct impact on the intensity of technological changes in industry, affecting the technological structure and technological development of the national industry. In this context, government regulation should be considered as an external factor of the third level, which determines the development of individual production ecosystems through the regulation of the intensity of the above factors or the direct implementation of changes in the industrial enterprises that use government support measures.

**Theoretical foundations of the research**

Fast and unpredictable technological changes create a gap between the existing and required by the external environment level of technological development of an enterprise [Suarez, Lanzolla, 2007]. This gap increases the risk of losing competitive advantages and forces companies to constantly adjust their business models, update technologies and develop material and production base. For industrial enterprises, this task is not simple due to the high capital intensity and high costs for qualified personnel. Therefore, technological strategies are the most important component of the management system of any industrial enterprise.

At the same time, as Orekhova shows, the features of the industrial enterprises functioning (specific contractual relations, low strategic flexibility, competition through machinery and technology, linking their development strategies with government programs, etc.) make them very sensitive to institutional and the technological context in which they operate [Orekhova, 2016]. In fact, compliance with the technological context is the key task of the company’s technological development strategy. The institutional context is a set of political and economic rules that create or restrict the opportunities for the development of economic entities [Glazyev, 2019].

The imperfection of the institutional environment is especially relevant for countries with developing economies – they are characterised by failures and inefficiency of the legal infrastructure, in particular with regard to intellectual property rights [Steinfeld, Beltoft, 2014]. In the absence of reliable legal protection, competing firms may be prone to opportunism and unfair competition, using the results of innovation and research activities of competitors [Jugend et al., 2018]. This increases the uncertainty of obtaining rent from new developments and the use of new technologies. Investors may try to protect their funds by raising the required rate of return, which, in its turn, reduces the economic efficiency for the producer itself [Meyer...
et al., 2009]. All this forces manufacturers to increase the speed of development of new technologies and products in order to stay ahead of competitors, and increase the degree of information protection of the production process, which leads to additional costs.

In this situation, financial instruments of state support act as a means of compensating for the weakness of the institutional environment [Nuruzzaman, Singh, Gaur, 2020]. However, in order to receive this support, enterprises have to meet certain criteria and coordinate their development objectives with the development objectives of the country or territory where they are located. To a certain extent, this serves as a constraint of their technological strategies. Weak institutions do not allow companies to accurately interpret the intentions of the state regarding the directions of the country’s development, despite the fact that, in order to reduce the ambiguity of information, the authorities signal their interests and intentions through development plans, policies, and government programs [Marquis, Raynard, 2015]. In fact, the framework of state support creates a situation of institutional pressure [Marquis, Raynard, 2015], when enterprises are forced to coordinate their strategic priorities not only with competitive conditions, but also with the priorities of economic development, which often do not meet the requirements of a dynamically changing external environment.

Industry conditions also have a significant impact on the technological development strategies implemented by enterprises. The industrial market is characterised by different rates of technological changes. Technological turbulence is a source of high uncertainty for producers and ‘imposes’ the logic of proactive actions [Nadkarni, Barr, 2008; Khanna, Guler, Nerkar, 2016]. This means that companies develop new technologies and products through experimentation and search but they do not base on previous experience [Bao, Su, Noble, 2021]. Although this has a positive effect – it reduces the probability of trajectory dependence on previous experience, the so-called path dependence [Auzan, 2015], the results of such activities quite often contradict the priorities set by the state [Khanna, Guler, Nerkar, 2016].

In addition, the function of accumulating technological knowledge by a company itself atrophies due to the lack of its necessity, but the importance of the ability to acquire new knowledge for technological development increases [Guimaraes, Paranjape, Walton, 2019]. Thus, the internal opportunities of firms, described as resources, are concentrated in capabilities, and not only in tangible and intangible assets and their hard-to-copy combinations. Mastering the ability to catch or create a trend of technological development, quickly bringing a product or new technology to the market determines the strategy of the technological development of the enterprise. This cognitive ability is referred to as absorbing, since it characterises
the company’s ability to identify, acquire, assimilate and use external knowledge for commercial use [Cohen, Levinthal, 1990; Zahra, George, 2002; Murovec, Prodan, 2009].

A number of studies found that high absorption capacity helps a company mitigate the effects of legal inefficiency [Murovec, Prodan, 2009] and more closely meet the parameters of government support [Guimaraes, Paranjape, Walton, 2019]. Thus, by increasing this capacity, a company can better deal with institutional pressures by incorporating national economic development priorities into its strategic actions and protecting its technology from being copied. However, the acquired ability to adequately respond to institutional pressure is offset by technological turbulence, if it is typical for the industry [Todorova, Durisin, 2007; Wales, Parida, Pate, 2013; Wu, Liu, Zhang, 2017].

The composition of resource, sectoral and institutional factors that determine the strategies for the technological development of an industrial enterprise are poorly studied. Researchers propose considering such components as unfair competition, facts of violation of intellectual property rights, the period of emergence of new technologies in the industry, the amount of financial state support, etc. [Bao, Su, Noble, 2021]. If we talk about the factors of technological development in general, they are usually grouped into legal, geopolitical, natural-ecological, sociocultural, etc. [Zai-chenko, Rud, Kuznetsov, 2014; Simachev et al., 2014; Komkov, 2017].

**Research methods**

The objective of the study was to identify the conditions that most determine the technological development strategy of an industrial enterprise.

The field phase of the work was done in February – May 2021. 148 experts from the Sverdlovsk and Chelyabinsk regional branches of OOO “Russian Engineering Union”¹ and the Union of Defence Industry Enterprises of the Sverdlovsk oblast, including current managers and specialists of mechanical engineering companies², took part in the survey.

¹The OOO “Russian Engineering Union” is a voluntary, socially oriented, self-governing, all-Russian public association based on membership. Its members are individuals and legal entities. The Sverdlovsk regional branch includes about 4 thousand members – individuals (mainly employees of machine-building companies) and 42 members – legal entities, including mechanical engineering enterprises of the Sverdlovsk oblast (about 80 % are from the defence industry), higher educational institutions, and other organisations. The Chelyabinsk regional branch includes about 1.5 thousand members – individuals and 30 members – legal entities, including mechanical engineering enterprises, educational institutions and infrastructure organisations that support the development of industrial business in the region. (in Russ.)

²The Union of Defence Industry Enterprises of the Sverdlovsk oblast is a non-profit organisation that unites 96 enterprises and organisations, including 38 large military-industrial plants, 16 research institutes and design bureaus, 22 small innovative research and production enterprises, as well as infrastructure organisations, including higher educational institutions, banks, transport and logistics, insurance companies, etc. (in Russ.)
To ensure uniformity of the research terminology, we adopted the following thesis: the technological development strategy of an industrial enterprise is made up of three determinants – institutional, resource and sectoral factors. These determinants are formed by components – conditions that define the objectives and content of the strategy.

The lack of information about the composition of the factors led us to the need for a preparatory stage, during which it was expected to obtain a large amount of unstructured data. In this regard, the number of respondents was limited to 150 people, two of whom later refused to continue participating in the surveys.

The research included the following stages.
1. Identifying the conditions, which, according to the respondents, determine the technological development strategy of an industrial enterprise to the greatest extent by the method of continuous survey. The questionnaire was compiled using the principles of the Delphi method.
2. Distinguishing the most essential conditions applying the grouping method with a simple calculation of the most frequently encountered options, taking into account the morphology and variability of the formulations, which were limited by the keywords. The result of this stage was a questionnaire that included the 10 most common components, grouped according to three strategic determinants.
3. Carrying out a survey using the questionnaire. The respondents were asked to rate the significance of conditions on a scale from 1 to 10 (the stronger the influence, the higher its rank). The results were processed by constructing a multiple logit regression model.
4. Conducting in-depth interviews with experts – survey participants. The subject of the interview was the relationship between the strategy determinants of technological development. It was necessary to give a detailed answer to the following questions:
   • Do the mechanical engineering enterprises of the region (your company) respond to technological turbulence (uncertainty of the prospects for technological development) in the industry with the help of their internal resources and / or use instruments of state support?
   • What progressive methods of technology development (for example, rapid prototyping, agile and / or stage & gate approaches) are used in the mechanical engineering enterprises in the region (in your company)? Do they help to reduce the state of uncertainty of technological development in the industrial market? Does the high speed of development allow you to fight against the technology theft?
   • How do you assess the absorption capacity of regional mechanical engineering enterprises (your company) in relation to new technologies? This question was
detailed by the following questions: how often do mechanical engineering companies in the region (your company) cooperate with universities or research organisations on the joint development of technologies? How often do mechanical engineering companies in the region (your company) acquire the results of intellectual activity? How intensively do mechanical engineering companies in the region (your company) update technologies? What are the factors of the institutional and industry environment that most limit or, conversely, expand the capabilities of an industrial enterprise to develop technologies?

As a result, qualitative data were obtained, the interpretation of which was to conduct a binary assessment of pairwise comparisons.

5. Summarising and formulating conclusions.

Research results and discussion

The first stage of the study, as it has already been mentioned, was in the form of a continuous survey. The questionnaire included open-ended questions, suggesting free formulation of answers. The respondents’ answers were initially divided into three groups according to the three determinants of technological development strategies. A total of 379 positions were obtained that describe the components of strategic determinants. Next, a morphological analysis and grouping of positions within the determinants were carried out according to the keywords defined for each group. As a result, 10 components of the determinants of technological development strategies were formulated (Table 1).

At the next stage, a survey was done among the respondents who participated in the first stage.

Given the widespread occurrence of logit regressions in econometric modeling, their high efficiency in the analysis, as well as the need to assess the combined effect of three determinants (10 components in total) of the technological development strategy of a manufacturing company, an econometric model of the following type was chosen as the basic one:

$$Y = f(x_1, x_2, \ldots x_n),$$

where, $n$ represents 1, 2, ... 10; $x_1$ is regulatory and legislative innovations; $x_2$ is government support; $x_3$ is the level of economic freedom, including the choice of areas of business and technological modernisation; $x_4$ is violation of the rules of market interaction and regulation by other stakeholders (including oligopolisation and monopolisation of markets); $x_5$ is accumulated technological base (fixed assets, intangible assets, tacit knowledge); $x_6$ is highly qualified engineering personnel; $x_7$ is investment resources (own, attracted); $x_8$ is average industry profitability and
the level of tax burden; \( x_9 \) is the level of transaction costs of doing business and implementing projects on technological modernisation of production in the industrial market; \( x_{10} \) is technology update rate, technological turbulence.

For each component, the significance of the factors \( x_i \) was calculated in accordance with their importance for the technological development strategy, and then a matrix of initial data was built for the implementation of multiple logit regression analysis.

Taking into account the substantial number of the factors and subjectivity in the respondents’ answers, we checked the resulting model for multicollinearity using the Farrar – Glober algorithm, as a result of which a linear relationship between the components was revealed and insignificant components, which distort the model, were removed (Table 2).

| no. | Components                                                                 | Assessment of the influence of components on the choice of a technological development strategy, points |
|-----|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| 1.  | Regulatory and legislative innovations                                       | from 1 to 10                                                                                       |
| 2.  | Government support                                                           |                                                                                                     |
| 3.  | Level of economic freedom, including the choice of areas of business and technological modernisation |                                                                                                     |
| 4.  | Violation of the rules of market interaction and regulation by other stakeholders (including oligopolisation and monopolisation of markets) |                                                                                                     |
| 5.  | Accumulated technological base (fixed assets, intangible assets, tacit knowledge) | from 1 to 10                                                                                       |
| 6.  | Highly qualified engineering personnel                                       |                                                                                                     |
| 7.  | Availability of investment funds (own, attracted)                           |                                                                                                     |
| 8.  | Industry average profitability and tax burden                               |                                                                                                     |
| 9.  | Level of transaction costs of doing business and implementing projects on technological modernisation of production in the industrial market | from 1 to 10                                                                                       |
| 10. | Technology update rate. Technological turbulence                           |                                                                                                     |
Table 2. Results of multivariate regression analysis of the components’ significance for the technological development strategy

| Indicators                          | \( y \)     | \( x_1 \) | \( x_2 \) | \( x_3 \) | \( x_4 \) | \( x_5 \) | \( x_6 \) |
|------------------------------------|-------------|-----------|-----------|-----------|-----------|-----------|-----------|
| Average values                     | 2.6194      | 0.9957    | 0.6805    | 0.8555    | 0.8487    | 0.6259    | 0.5651    |
| Paired correlation coefficients \((r_{xy})\) | –           | 0.5279    | 0.4883    | 0.5092    | 0.4820    | 0.5632    | 0.4948    |
| Standard deviations \((\sigma_i)\) | 1.3877      | 1.0730    | 0.8095    | 1.0573    | 0.9196    | 0.5622    | 0.6510    |
| \( \beta \)-coefficient \((\beta_i)\) | –           | 0.4082    | 0.2849    | 0.3880    | 0.3194    | 0.2282    | 0.2321    |
| Elasticity coefficients \((E_i)\)   | –           | 0.2007    | 0.1269    | 0.1663    | 0.1562    | 0.1346    | 0.1067    |

Note: \( x_1 \) represents regulatory and legislative innovations; \( x_2 \) is technology update rate; \( x_3 \) is investment resources (own, attracted); \( x_4 \) is the level of economic freedom, including the choice of areas of business and technological modernisation; \( x_5 \) is the level of transaction costs of doing business and implementing projects on technological modernisation of production in the industrial market; \( x_6 \) is violation of the rules of market interaction and regulation by other stakeholders (including oligopolisation and monopolisation of markets).

As a result, the regression equation characterising the importance of the components for the technological development strategy of an industrial enterprise turned out to be as follows:

\[
y_x = 0.6280 + 0.3815 x_1 + 0.4724 x_2 + 0.3552 x_3 + 0.3139 x_4 + 0.7263 x_5 + 0.4688 x_6.
\]

The analysis of the strength of the relationship indicated that there was a medium correlation between the dependent variable and factors, i.e. the obtained values of the paired correlation coefficients are within the inequality: \(0.3 < r_{xy} < 0.6\) (Table 3).

Table 3. Parameters of the regression dependence characterising the components’ significance for technological development strategies of industrial enterprises

| Parameter             | \( a_0 \) | \( a_1 \) | \( a_2 \) | \( a_3 \) | \( a_4 \) | \( a_5 \) | \( a_6 \) |
|-----------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| \( \mu(a_i) \)        | 0.0960    | 0.0523    | 0.0679    | 0.0513    | 0.0591    | 0.0976    | 0.0842    |
| \( R^2 \)             | 0.10368   | 0.056484  | 0.073332  | 0.055404  | 0.063828  | 0.6283    | 0.8030    |
| F-criterion           | 132.865   | 174.64    | 118.6427  | 159.84    | 108.5883  | 148.0000  | 100.5447  |

The analysis of the parameters of the resulting model revealed that, according to the respondents, the strategic determinants included in the model define the prospects for technological development by 80.3 %. The adequacy of these results is confirmed by the actual value of the \( F \)-criterion exceeding the table one. The level of
transaction costs prevailing in the industrial market has a significant impact \( (a_5 = 0.7263) \). When planning technological modernisation and introducing new innovative technologies, enterprises need to take into account the effect of such components of institutional and resource determinants as regulatory and legislative innovations, violation of market rules and market behaviour by other stakeholders, as well as the availability of investment resources.

Decomposing total variation of the assessment of the components’ significance into the variation of factors included in the model \( (\beta\)-coefficient) is important for determining the reserves for the implementation of technological development strategies. Thus, the greatest reserves are in reducing the negative institutional impact of legal and regulatory frameworks. According to the respondents, a crucial component is government support. It is possible to see in the model obtained that if the percentage of government support for technological modernisation changes by one point in the standard deviation, the technological equipment of mechanical engineering enterprises will change by 0.39 % of its standard deviation.

The analysis of elasticity coefficients shows that an increase in the efficiency of the application of legal regulations by 1 % will decrease technological instability by 0.2 %, whereas a corresponding increase of the efficient use of government support can provide almost 0.17 % of the potential growth of the technological level of companies, etc.

Special attention should be paid to the partial coefficients of determination, calculated in order to assess the impact of each component in the total volume of variation (Table 4).

The data in Table 4 suggest that, in the opinion of the respondents, the components of the institutional determinant are of the highest importance (47.4 %). Three of the four relevant components were on the list of the most significant. The importance of the sectoral determinant is also high – 26.9 %. The least significant was the resource determinant, among the most significant there was only the availability of investment resources. This can probably be explained by a change in priorities in the value perception of resources: artificial intelligence technologies, robotisation, the possibility of remote work make attracting of highly qualified personnel an easy task, but a costly one, and the presence of worn-out fixed assets, obsolete intangible assets becomes a constraint to increasing the level of technological development of enterprises. The accumulated tacit knowledge in the context of modern production technologies also loses its value, which is getting worse by the increasing mobility of personnel.

The final stage of the study provided the following results.

Firstly, the overwhelming majority of respondents noted that the Russian practice of state support for industry is adequate only for industries with a relatively low rate
of technological change. Subsidies are often allocated for projects that have already lost their technological relevance, since during the time given for the procedure for providing funds, there are significant changes in technology.

Secondly, technological turbulence reduces the ability of companies to respond to institutional pressures, which is consistent with the findings of researchers [Bao, Su, Noble, 2021]. The respondents noted that a company cannot concentrate equally effectively on changes in institutional conditions and on changes in applied technologies. The focus will always shift to one side. Therefore, the technological development strategy, as a rule, tends either to adjust to the priorities of national objectives, or to attempts to integrate into global technological trends, which requires the ability to quickly respond to changes, but it reduces the likelihood of receiving state support. Balancing the strategy in this case is a relevant management task.

In the interview, we replaced direct questions about the absorption capacity of companies with questions about the availability of various kinds of resources, as well as about the intensity of technology exchange in the industry environment. In general, the responses on the resource determinant of the strategy were expected. The most significant component is the investment resources. According to the respondents,

| Indicator (component)                                                                 | Pairwise correlation coefficient | β-coefficient | Volume of influence of each component, % | Share of influence of each component |
|--------------------------------------------------------------------------------------|---------------------------------|---------------|------------------------------------------|-------------------------------------|
| $x_1$ – regulatory and legislative innovations                                        | 0.5279                          | 0.4082        | 21.5                                     | 0.25                                |
| $x_2$ – technology update rate                                                       | 0.4883                          | 0.2849        | 13.9                                     | 0.16                                |
| $x_3$ – investment resources (own, attracted)                                        | 0.5092                          | 0.3880        | 19.8                                     | 0.23                                |
| $x_4$ – level of economic freedom, including the choice of areas of business and technological modernisation | 0.482                           | 0.3194        | 15.4                                     | 0.18                                |
| $x_5$ – level of transaction costs of doing business and implementing projects on technological modernisation of production in the industrial market | 0.5632                          | 0.2282        | 12.9                                     | 0.15                                |
| $x_6$ – violation of the rules of market interaction and regulation by other stakeholders (including oligopolarisation and monopolisation of markets) | 0.4948                          | 0.2321        | 11.5                                     | 0.13                                |
| Total                                                                                | $x$                             | $x$           | 94.9                                     | 1.08                                |
their presence solves most of the issues related to the material base, human resources, intellectual property protection and the ability to quickly adapt to technological changes. The answers to the questions about the relevance of the accumulation of tacit knowledge were uncertain, possibly due to the inadequate understanding of this concept by the respondents. Only 15% of those surveyed reported on the use of progressive methods of developing technologies and products at enterprises. Others considered them fashionable terms. At the same time, more than half of the survey participants indicated a high intensity of technological exchange with the external environment.

Detailed answers make it possible to formulate the following theses.

State support has little effect on the intensity of accumulation and exchange of technological knowledge, since subsidies are granted, as a rule, for projects on the production base modernisation. The systematic nature of the development of technologies does not correspond to the project approach to the implementation of government support.

The legal ineffectiveness of protecting the results of intellectual activity significantly reduces the desire of companies to be engaged in developments in favour of acquiring technologies abroad. Experts point out that the cost of acquiring technologies and the speed with which new technologies appear reduces the economic expediency of having an R&D department to practically zero. Defence technologies are an exception.

The respondents were offered pairwise comparison matrices (Table 5).

Table 5. Pairwise comparison matrices: Generalisation of respondents’ answers

| Strategy determinants | Institutional | Sectoral | Resource | Total |
|-----------------------|---------------|----------|----------|-------|
| Institutional         | –             | 1        | 1        | 2     |
| Sectoral              | 0             | –        | 1        | 1     |
| Resource              | 0             | 0        | –        | 0     |

Using the theoretical models of other researchers [Nuruzzaman, Singh, Gaur, 2020] and our data, we can argue that the technological development strategy is determined not only by an enterprise itself allowing for its production capabilities and the requirements of the competitive environment. To the greatest extent, this strategy is determined by the institutional conditions, which an enterprise is built in. However, the ability of companies to adequately respond to institutional pressures and transform their resource base is largely determined by the speed and intensity of technological change in the industry.
Conclusion

When designing strategies for technological development, enterprises face not only limited resource opportunities, they also have to take into account the conditions of the industrial market and the institutional environment.

The analysis of the regression model built to assess the significance of the determinants of the technological development strategy of an industrial enterprise, demonstrates that such institutional, sectoral and resource components as the prevailing level of transaction costs, a favorable legislative environment and the availability of investment resources have the strongest impact on the technological development.

The use of the tripod strategy perspective allowed us to consider the determinants of the technological development strategy of an industrial enterprise not in isolation, but in the context of the assumption of their mutual influence. A fluid institutional environment and technological change produce both constraints and opportunities. Developing a technological development strategy, balanced according to the three pillars, can be an effective tool for an industrial enterprise to achieve its competitive success.

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