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HIGHER SCHOOL OF ECONOMICS

*Anastasia Edelkina, Oleg Karasev,
Marina Klubova*

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TECHNOLOGICAL CAPACITY OF
A HIGH TECH COMPANY TO
MARKET DEMAND: A
PORTFOLIO MATRIX APPROACH**

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Anastasia Edelkina¹, Oleg Karasev², Marina Klubova³

LINKING THE SCIENTIFIC AND TECHNOLOGICAL CAPACITY OF A HIGH TECH COMPANY TO MARKET DEMAND: A PORTFOLIO MATRIX APPROACH

This paper presents a novel methodology for assessing the most promising technologies of a high tech company taking into account market demand and the available scientific and technological capacities. The Technology Portfolio Matrix (TPM) is used as a tool for project screening by linking the science and technological capacities of a high-tech firm with market attractiveness of its technologies. The recommendations for the strategic management are proposed on the basis TPM in accordance with portfolio analysis theory.

Key words: portfolio analysis, technology portfolio matrix, high-tech company, S&T capacities, market attractiveness.

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¹ Junior Research Fellow, [Research Laboratory for Science and Technology Studies](#), International Research and Educational Foresight Center, Institute of Statistical Sciences and Economics of Knowledge, Higher School of Economics. Corresponding author. Email: aedelkina@hse.ru

² Deputy Director, International Research and Educational Foresight Center, Institute of Statistical Sciences and Economics of Knowledge, Higher School of Economics. Email: okarasev@hse.ru

³ Research Fellow, International Research and Educational Foresight Center, Institute of Statistical Sciences and Economics of Knowledge, Higher School of Economics. Email: mklubova@hse.ru

THEORETICAL BACKGROUND

Research and successful business practice show the variety of approaches to the assessment of technological development and the market potential of high-tech firms. Among those approaches are those developed by Arthur D. Little (ADL), Boston Consulting Group (BCG), McKinsey and General Electric Corporation (McKinsey/GE), and Shell. Originally the assessment approaches were developed by consulting companies and used for long time already but less frequently discussed in academic literature. Accordingly most approaches are related to strategic management approaches to the market analysis. The analysis of market prospects are represented by a system of coordinates: market growth rates and the relative market share (BCG, 1968; Henderson, 1979; Wensley, 1981; Hax, 1983; Mikkola, 2001; Fleisher and Bensoussan, 2002). Among the advantages of this approach are the simple visual illustration and low information costs. The main limitation is that the analysis takes into account only the market side and it does not give an assessment of scientific and technological capabilities of the company.

The BCG approach has been expanded taking this into account (Ghemawat, 2002). ADL, a management consulting company offered new approach (Patel & Younger, 1978; Udo-Imeh, 2012) using two parameters. The first reflects sector maturity, the second the positions of the company in relation to its competitors. The ADL approach known as TechFactor™ is a flexible tool for developing strategy, allowing a strategy according to the current stage of sector's innovation cycle and the level of competitiveness of the company in the market. The TechFactor method can be used in scenario planning, opportunity evaluation, portfolio management, consensus building, etc. It allows to evaluate the "what if" scenarios for technology commercializing and options for extracting value from the technology (Hastbacka, Houry, 1996).

Another modification was developed by McKinsey and General Electric. One of the key characteristics of this model (McKinsey/GE) is its application in defining a part of the company and a comparison with its competitors (Mikkola, 2001; Fleisher and Bensoussan, 2002; Ghemawat, 2002). This approach considers two aspects, the market attractiveness of the technologies and the level of competitiveness in the area of its technological competence. This approach is an effective tool for determining priorities in technology development and for making decisions on investment, and the redistribution of resources. In strategic planning Shell used a hybrid of the BCG and McKinsey/GE matrices (Hussey, 1978; Wind et al., 1983). The difference from the previous approaches is in the criteria of the strategic choice of priorities. In the BCG model the criterion is an assessment of cash flow, which is an indicator of short-term planning. In the GE/McKinsey model it is an assessment of ROI, which is an indicator of long-term planning. The Shell model takes into account both these indicators.

Eventually it shows that there is a range of different approaches for technology assessment and technology portfolio development (Small, 1999; Joly, 2003; Dickinson et al., 2001). Therefore the paper proposes a methodological approach which takes into account a broader number of criteria and an algorithm for assessing technologies and developing technology portfolios. In this regard, a system of evaluation criteria for promising technologies and products from the perspective of market needs and the available scientific and technological capacity is proposed.

METHODOLOGY

The integrated indicators reveal the most promising technologies of hi-tech companies taking into account market demand, and scientific and technological capacities. Indicators of the

technological level of the development and the degree of its technological readiness are used to assess the scientific and technological potential. Market size, growth rate, market share, the possibility of entering the market are used to assess the market potential for commercialization.

Based on the integrated indicators all technologies in a company, whether being developed or planned, are ranged using three integrated indices: the index of technological competence; the index of market prospects and; the index of potential technological usage.

The analysis of results is presented as TPM emphasizing company's priority areas for scientific and technological development.

The integrated indices are based on the analysis of available data and expert information, characterizing the technologies' market potential and the company's capacities. The "technology profile" summing up the research results and from this a database was generated to calculate the indices characterizing the following:

- the scientific and technological capacities of the company — an integrated index of the organization's technological competence, estimations of the quality of technologies and their technological readiness;
- the demand for technologies — an integrated index of the technologies' market potential, calculated using estimations of overall market perspective and company's potential for promotion to this market;
- an integrated index of the possibilities of using the technological potential of the company to satisfy market demand for technologies.

Table 1 presents a description of the indices and also a list of the indicators necessary for their calculation.

Table 1

System of integrated indexes

Indexes	Description	Indicators for index calculation
1. Integrated index of technological competences	Integrated estimation of a complex of the factors defining technological level of technologies and their technological readiness in comparison with the best competing analogues in Russia and in the world	<ul style="list-style-type: none"> • Estimation of quality of technology • Estimation of technological readiness
1.1. Index of technological level of technology being developed or planned for development in a company	Estimation of quality of technologies (value of their technical characteristics) in comparison with the best analogues in Russia and the world	<ul style="list-style-type: none"> • Technical characteristics of technology • Technical characteristics on the best analogue in Russia • Technical characteristics on the best analogue in the world • Estimation of importance of technical characteristics
1.2. Index of technological readiness of technology being developed or planned for development in a company	Estimation of level of technological readiness in comparison with the best analogues in Russia and the world	<ul style="list-style-type: none"> • Time for completion of separate stages of an innovative life cycle of technologies • Time for completion of separate stages of an innovative life cycle of the best analogue of technology

Indexes	Description	Indicators for index calculation
		in Russia <ul style="list-style-type: none"> • Time for completion of separate stages of an innovative life cycle of the best analogue of technology in the world
2. Integrated index of market prospect	Integrated estimation of a complex of the factors defining market potential for commercialization of technologies in Russia and abroad	<ul style="list-style-type: none"> • Estimation of perspective of the market • Estimation of company's market promotion potential • Estimation of a current and potential (in 10-15 years) market shares of the company
2.1. Index of market perspective	Estimation of market volumes and their dynamics in Russia and abroad where commercialization for technologies is possible	<ul style="list-style-type: none"> • Estimation of market volumes • Estimation of market growth rates in the next 10–15 years
2.2. Index of company's market promotion potential	Estimation of possibilities to enter perspective markets for commercialization of technologies	<ul style="list-style-type: none"> • Estimation of market volumes • Estimation of market growth rates in the next 10–15 years • Estimation of possibilities to enter the perspective markets
3. Integrated index of possibilities to use of technological potential of the company	Integrated estimation of a complex of the factors defining possibilities of getting benefits from use of scientific and technological capacities according to the market demand	<ul style="list-style-type: none"> • Index of perspectives of company's market promotion potential • Index of the comparative technological competence of the company

Source: authors' analysis.

Further details on the methodology of each index calculation and their interpretation are provided below.

The calculation of the index of technological level

The index shows the presence or absence of advantages under the key characteristics of the technologies.

The quantitative estimates of factors defining the level of company's technologies are considered at calculation of the given index. The index value is the weighted sum of expert estimations according to the following:

- the comparative estimations of the technology's value with similar competing technologies developed in Russia;
- the comparative estimations of the technology's value with similar competing technologies developed abroad;
- the comparative estimations of the technology's value with level at which that technology becomes competitive;
- estimations of level of importance of the specified characteristics for the competitiveness of the technology.

Key parameters of the technological level index of company's development are presented in Table 2.

Table 2

Calculation parameters of technological level index of company's development

Indicator	Calculation parameters
Technology	t_i , where i — technology number
Normalized value of the characteristic of technology of the company in comparison with the best analogues in Russia	$x_1^r, x_2^r, x_3^r, \dots, x_j^r$, where j — number of characteristics of technology t_i
Normalized value of the characteristic of technology of the company in comparison with the best analogues in the world	$x_1^w, x_2^w, x_3^w, \dots, x_j^w$, where j number of characteristics of technology t_i
Normalized value of the characteristic of technology of the company in comparison with value at which the technology becomes competitive	$x_1^c, x_2^c, x_3^c, \dots, x_j^c$, where j — number of characteristics of technology t_i
Value of importance of technologies' characteristics	$m_{x_1}, m_{x_2}, m_{x_3}, \dots, m_{x_j}$
The weighted factors defining the importance of excess / backlog of values of characteristics of the company from values of characteristics of the best analogues in Russia, in the world and from competitiveness level	k^r — coefficient of the importance of excess / backlogs of values of characteristics of the company from values of characteristics of the best analogues in Russia k^w — coefficient of the importance of excess / backlogs of values of characteristics of the company from values of characteristics of the best analogues in the world k^c — coefficient of the importance of excess / backlogs of values of characteristics of the company from competitiveness level
Index of technological level of development (for technology t_i)	$I_Q^{t_i}$

Source: authors' analysis.

The index of the level of technology is calculated by the formula:

$$I_Q^{t_i} = \frac{\sum_j \left(\frac{k^r \times x_j^r + k^w \times x_j^w + k^c \times x_j^c}{k^r + k^w + k^c} \times m_{x_j} \right)}{\sum m_{x_j}}$$

The designations used in the formula are described in Table 2.

The value of the index shows the strength of the company for the key characteristics of technologies in comparison with competitors.

The values of indices are converted to a scale from 0 to 1 for the comparison with other technologies. The following formula is used:

$$\widetilde{I}_Q^{t_i} = \frac{I_Q^{t_i} - I_Q^{t_i}(min)}{I_Q^{t_i}(max) - I_Q^{t_i}(min)},$$

where $I_Q^{t_i}(min)$ is the minimum possible value; $I_Q^{t_i}(max)$ is the maximum possible value.

An index gets the maximum value (i.e. 1) when the company's technology has essential advantages and leads on quality in comparison with competitors, and the minimum value (i.e. 0) when the company's technology significantly lags behind competitors.

The calculation of the technological readiness index

The technological readiness index shows the presence or absence of advantages in the time for the completion of the separate stages of an innovation cycle of technology.

The quantitative estimations of factors defining the level of technological readiness are considered at the calculation of the given index. The value of an index is the weighted sum of expert estimations on following positions:

- the comparison of the expected completion time for the separate stages of an innovation cycle with the best analogues in Russia;
- the comparison of the expected completion time for the separate stages of an innovation cycle with the best analogues in the world.

Key parameters of calculation of technological readiness index presented in Table 3.

Table 3

Calculation parameters of index of technological readiness

Indicator	Calculation parameters
Stages of development of technologies	$d_{t_i}^{y^1}, d_{t_i}^{y^2}, \dots, d_{t_i}^{y^j}, \dots, d_{t_i}^{y^n}$, где j — year, $y^1 = ["2015"], \dots, y^n = ["2030"]$ $d_{t_i} = ["fundamental research"] = 0,25$ $d_{t_i} = ["research"] = 0,5$ $d_{t_i} = ["development"] = 0,75$ $d_{t_i} = ["mass production"] = 1$
Advantages of the company from the leader in Russia on terms of development of technology	$D_{y_j}^r$ <ul style="list-style-type: none"> • if the current stage of development of the company's technology exceeds or corresponds to a stage of development of the leader in Russia, so the given parameter gets value «1» (the maximum advantage on development terms is reached); • otherwise $D_{y_j}^r$ is calculated as: [1 - (a current stage of development of analogue in Russia - a current stage of development of a technology in company)]
Advantages of the company from the leader in the world on terms of development of technology	$D_{y_j}^w$ <ul style="list-style-type: none"> • if the current stage of development of the company's technology exceeds or corresponds to a stage of development of the leader in the world, so the given parameter gets value «1» (the maximum advantage on development terms is reached); • otherwise $D_{y_j}^w$ is calculated as: [1 - (a current stage of development of analogue in the world - a current stage of development of a technology in company)]
The weighted factors defining the importance of advantages of the company from leaders in Russia and abroad	k^r — coefficient of the importance of backlog of the company from leaders in Russia k^w — coefficient of the importance of backlog of the company from leaders in the world
The weighted factors showing the change of the importance of advantages of the company in comparison with leaders in Russia and abroad	$\beta^{y^1}, \beta^{y^2}, \dots, \beta^{y^j}, \dots, \beta^{y^n}$, где j — year, $y^1=2015$; $y^n= 2030$. β — it changes from 1 to 0. The value of coefficient, i.e. the importance of advantages of the company, decreases through years because of higher level of uncertainty in long term, and also possibility of speeding up of terms of development on competitors side
Index of technological readiness (for technology t_i)	$I_R^{t_i}$

Source: authors' analysis.

The index of technological readiness is calculated using:

$$I_R^{t_i} = \frac{\sum_j (k^r \times D_{y_j}^r + k^w \times D_{y_j}^w \times \beta)}{\sum \beta}$$

The coefficient $D_{y_j}^r$ ranges from 0 to 1. If the development stage of the technology in year y_j exceeds or corresponds to the stage of development of the best analogue in Russia in year, $D_{y_j}^r = 1$. Otherwise the advantage of the company $D_{y_j}^r$ is calculated as:

$$D_{y_j}^r = 1 - (D_{y_j}^R [\text{best analogue in Russia}] - D_{y_j}^C [\text{company}])$$

The higher the value of an indicator, the less backlog of development. Calculations $D_{y_j}^w$ are as in case $D_{y_j}^r$.

The value of the index shows advantages of the company on terms of development of technology in comparison with competitors.

The values of indexes converted to a scale from 0 to 1 to compare all technologies. The following formula is used:

$$\tilde{I}_R^{t_i} = \frac{I_R^{t_i} - I_R^{t_i}(\min)}{I_R^{t_i}(\max) - I_R^{t_i}(\min)},$$

where $I_R^{t_i}(\min)$ is the minimum possible value of an index; $I_R^{t_i}(\max)$ is the maximum possible value of an index.

The maximum value (i.e. 1) means that the company's technology is ahead in the degree of technological readiness in comparison with leaders in Russia and abroad.

The minimum value (i.e. 0) means that the company's degree of technological readiness considerably lags behind leaders in Russia and abroad.

The calculation of the integrated technological competence index

This index characterizes the prospects of technological development taking into account the level of technical characteristics and the time for completion of separate stages of the innovative cycle in comparison with the best analogues in Russia and the world. The index value shows the significance of the scientific and technological reserves of the company for the technologies.

The index is calculated as an arithmetic mean of an index of technological level and an index of technological readiness. The index is calculated using:

$$I_{TC}^{t_i} = \frac{\tilde{I}_Q^{t_i} + \tilde{I}_R^{t_i}}{2}$$

The value of an index is between 0 and 1 and shows the presence or absence of technological advantages. The maximum value, (i.e. 1), means that the company has essential scientific and technological reserves, surpassing those in Russia and abroad on the quality (value of technical characteristics) and technological readiness (time for completion of separate stages of an innovative cycle). The minimum value, (i.e. 0), means that the company's technology considerably lags behind leaders in Russia and abroad in terms of quality and development.

The calculation of the market prospect index

The market prospect index characterizes the volume and dynamics of the markets in which the commercialization of the technology in the next 10–15 years is possible. The index shows

the market prospects in Russia and abroad. The value of an index is the weighed sum of expert estimations on following positions:

- the market volume in Russia and in the world;
- the market growth rates in the next 10–15 years in Russia and in the world.

Key parameters the index are presented in Table 4.

Table 4

Calculation parameters of index of market perspective

Indicator	Calculation parameters
Volume of the markets on which commercialisation of the company's technology is possible	V_1, V_2, \dots, V_j , где j — market number on which technology commercialisation is possible
Markets growth rates on which commercialisation of the company's technology is possible in the next 10-15 years	$T_1, T_2, T_3, \dots, T_j$, где j — market number on which technology commercialisation is possible
The weighted coefficients defining the importance of volumes and dynamics of the markets in Russia and abroad	k^r — coefficient of the importance of market perspective of a technology for commercialisation on the Russian market k^w — coefficient of the importance of market perspective of a technology for commercialisation on the world market
Index of market perspective (for technology t_i)	$I_{M1}^{t_i}$

Source: authors' analysis.

The index of the market perspective is calculated using:

$$I_{M1}^{t_i} = \frac{k^r \times \frac{\sum V_j^r \times T_j^r}{\sum j} + k^w \times \frac{\sum V_j^w \times T_j^w}{\sum j}}{k^r + k^w}$$

The value of an index varies from 0 to 1 and shows how large the markets are and how significant their growth potential is measured by means of expected growth rates in Russia and abroad in the next 10–15 years.

The maximum value, (i.e. 1), means that the markets are large and fast-growing. The minimum value, (i.e. 0), means that the markets are small and growth rates are low.

The calculation of the company's market promotion potential index

The market promotion potential index is calculated for the further estimation of attractiveness of future markets for company's technology. This index in addition to market volumes and dynamics considers possibilities of new players entering the markets. The index shows the size of the possibilities of entry of the company in the large and fast-growing markets.

The value of an index is the weighed sum of the estimations of:

- the market volume;
- the market growth rates in the next 10–15 years;
- the entry barriers on the markets.

The index characterizes the expected market demand taking into account the possibilities of a new entry into the Russian and the foreign markets.

Key parameters of calculation of an index of company's market promotion potential are presented in Table 5.

Table 5

Parameters of calculation of an index of company's market promotion potential

Indicator	Calculation parameters
Volume of the markets on which commercialisation of the company's technology is possible	V_1, V_2, \dots, V_j , где j — market number on which technology commercialisation is possible
Markets growth rates on which commercialisation of the company's technology is possible in the next 10-15 years	$T_1, T_2, T_3, \dots, T_j$, где j — market number on which technology commercialisation is possible
The weighted coefficients defining the importance of volumes and dynamics of the markets in Russia and abroad	k^r — coefficient of the importance of market perspective of a technology for commercialisation on the Russian market k^w — coefficient of the importance of market perspective of a technology for commercialisation on the world market
Entry barriers	E_1, E_2, \dots, E_j , где j — market number on which technology commercialisation is possible The indicator changes from 0 to 1. The higher value of this indicator, the more possibilities of entry market. The values close to 0 testify to presence of essential entry barriers.
Index of company's market promotion potential (for technology t_i)	$I_{M2}^{t_i}$

Source: authors' analysis.

The index of market promotion potential is calculated using:

$$I_{M2}^{t_i} = \frac{k^r \times \frac{\sum V_j^r \times T_j^r \times E_j^r}{\sum j} + k^w \times \frac{\sum V_j^w \times T_j^w \times E_j^w}{\sum j}}{k^r + k^w}$$

The value of an index varies from 0 to 1 and shows how attractive the markets are from the perspective of their volumes, growth prospects, and entry possibilities in the next 10–15 years.

The maximum value, (i.e. 1), means that the markets are large, fast-growing, and entry barriers are absent. The minimum value, (i.e. 0), means that the markets are small, growth prospects are minimal, entry barriers are high.

The calculation of an integrated index of market prospects

The integrated index of market prospects characterizes the market attractiveness, including entry, and the current and future market share of the company. In addition to the basic characteristics of the market (volume, dynamics, entry barriers) the index estimates the market share of the company now and in the next 10–15 years.

The quantitative estimations of factors defining technological level of company's technologies are a calculation of the given index. The value of the index is the weighed sum of:

- the market volume;
- the market growth rates in the next 10–15 years;
- the entry barriers to the markets;
- the market share of the company now and in the next 10-15 years.

Key parameters of calculation of an index of market prospects of company's technology are presented in Table 6.

Table 6

Parameters of calculation of an index of market prospects

Indicator	Calculation parameters
Volume of the markets on which commercialisation of the company's technology is possible	V_1, V_2, \dots, V_j , где j — market number on which technology commercialisation is possible
Markets growth rates on which commercialisation of the company's technology is possible in the next 10-15 years	$T_1, T_2, T_3, \dots, T_j$, где j — market number on which technology commercialisation is possible
The weighted coefficients defining the importance of volumes and dynamics of the markets in Russia and abroad	k^r — coefficient of the importance of market perspective of a technology for commercialisation on the Russian market k^w — coefficient of the importance of market perspective of a technology for commercialisation on the world market
Entry barriers	E_1, E_2, \dots, E_j , где j — market number on which technology commercialisation is possible The indicator changes from 0 to 1. The higher value of this indicator, the more possibilities of entry market. The values close to 0 testify to presence of essential entry barriers
Market share that the company occupies now in Russia and abroad	s_t^r — market share that the company occupies now in Russia s_t^w — market share that the company occupies now abroad
Market share that the company can occupy in next 10-15 years in Russia and abroad	s_{t+1}^r — market share that the company can occupy in next 10-15 years in Russia s_{t+1}^w — market share that the company can occupy in next 10-15 years abroad
The weighted coefficients defining the importance of market shares of the company in Russia and abroad	α_t — coefficients defining the importance of market share that the company occupies now α_{t+1} — coefficients defining the importance of market share that the company can occupy in the next 10-15 years coefficients defining the importance of market shares of the company in Russia and abroad
Index of market prospects (for technology t_i)	$I_{MP}^{t_i}$

Source: authors' analysis.

The index of market prospects is calculated using:

$$I_{MP}^{t_i} = \frac{k^r \times \frac{\sum V_j^r \times T_j^r \times E_j^r \times \frac{\alpha_t \times s_t^r + \alpha_{t+1} \times s_{t+1}^r}{\alpha_t + \alpha_{t+1}}}{\sum j} + k^w \times \frac{\sum V_j^w \times T_j^w \times E_j^w \times \frac{\alpha_t \times s_t^w + \alpha_{t+1} \times s_{t+1}^w}{\alpha_t + \alpha_{t+1}}}{\sum j}}{k^r + k^w}$$

The value of index varies from 0 to 1 and shows the market prospects of the technologies and the possibility of increasing market share of the company now and in the next 10–15 years.

The maximum value, (i.e. 1), means that:

- the markets are large, fast-growing;
- entry barriers on the market are absent;
- the potential market share of the company is high.

The minimum value, (i.e. 0), means that:

- the markets are small;
- growth prospects are minimal;
- entry possibilities are limited;
- the potential market share of the company is insignificant.

The calculation of an integrated index of the possibilities of technological potential realization

This integrated index is the generalized characteristics of the possibilities for the development and commercialization of technologies. The index characterizes a complex of the factors defining the possibilities of the effective use of the scientific and technological reserves according to market needs.

The index is calculated as an arithmetic mean of an index of technological competencies and an index of market prospects calculated using:

$$I_{TM}^{t_i} = \frac{\widetilde{I}_{TC}^{t_i} + \widetilde{I}_M^{t_i}}{2}$$

The value of an index varies from 0 to 1 and shows how the scientific and technological reserves of the company match market demand for its technologies.

The maximum value, (i.e. 1), means that:

- the company has essential scientific and technological reserves, surpassing the level of competitors in quality (value of technical characteristics) and technological readiness (time for completion of separate stages of an innovative cycle);
- the expected market demand for the technology is high. The market prospects are characterized by large, fast-growing markets with low entry barriers and a low level of competition;

The minimum value, (i.e. 0), means that:

- the technology of the company considerably lags behind competitors in terms of quality and the completion of all stages of technology;
- a low demand for the company's technology is expected. The markets are characterised by small volumes, the minimum growth prospects, high entry barriers and a high level of competition.

RECOMMENDATIONS FOR THE IDENTIFICATION OF PRIORITIES

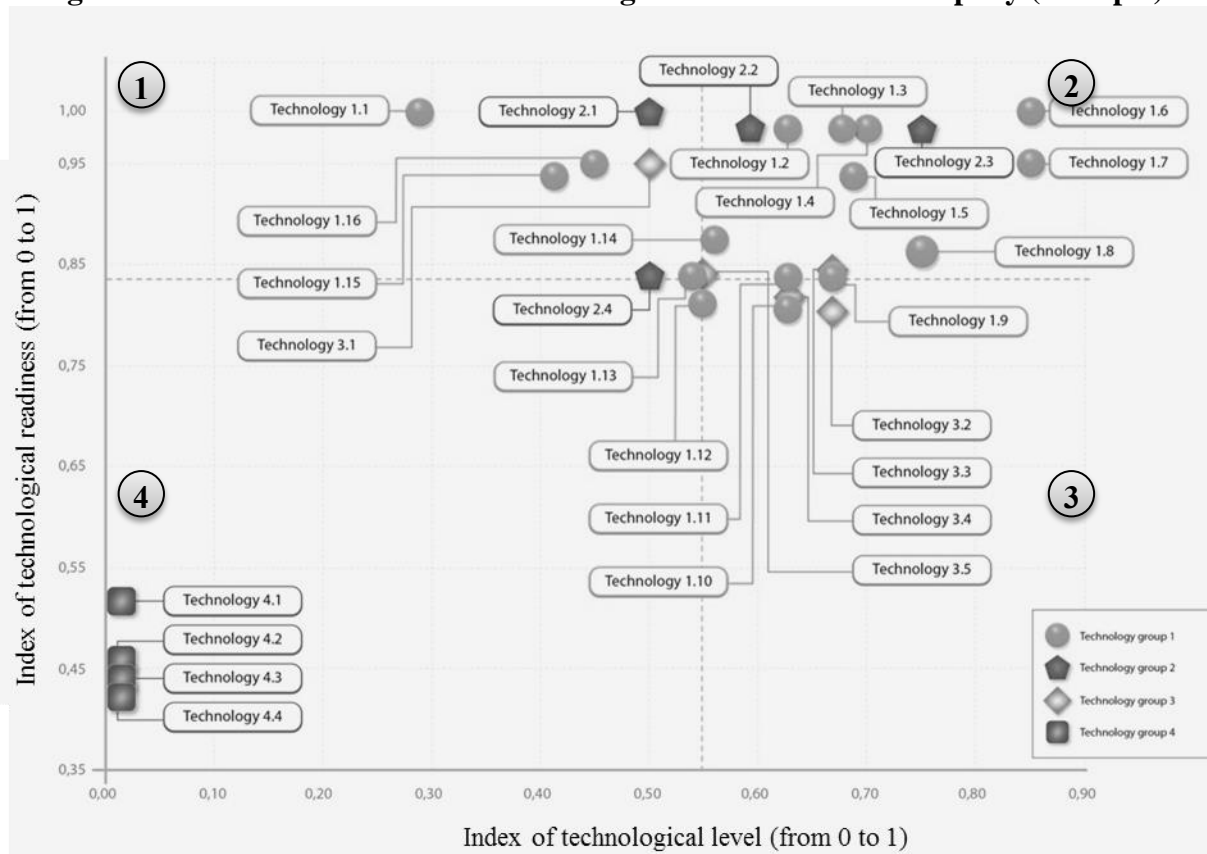
Based on the calculations presented in the previous section three integrated indexes are calculated: the index of technological competencies; the index of market prospects and; the index of the possibilities of the technological potential realization. According to values of the indices all technologies developed or planned by the company, are divided into four groups. Recommendations for each group of technologies for their further development are proposed in the corresponding technological areas.

Estimation of technological competencies

The estimation of the prospects of technological development is provided by means of a comparison of their characteristics, and the expected time for completion of separate stages of the innovative cycle.

The results illustrated by means of TPM are constructed in system of co-ordinates: the index of the technological level, reflecting a comparison of the characteristics technology with the best Russian and world level, and the index of technological readiness which defines expected time for completion of development and the beginning of its commercial use. Both indexes range from 0 to 1. All technologies are divided into four groups according to level of science and technological reserves of the company. The results are illustrated in Fig. 1.

Fig. 1 Estimation of scientific and technological reserves of the company (example)



Source: authors' analysis.

Note: the matrix is divided into 4 quadrants according to the median values of the index of technological level and an index of technological readiness.

Quadrant 1

The technologies developed or planned having competitive advantages in their technological readiness, are concentrated in the first quadrant of TPM.

In developing these technologies the company can exploit the first mover advantage by introducing the technologies before competitors. However the given group of technologies lags behind competitors on quality.

Quadrant 2

The technologies developed or planned, having competitive advantages on quality and degree of technological readiness are presented in the second quadrant of TPM. The given technologies are priorities for the company and can be introduced to the market quickly.

Quadrant 3

The technologies shown in this quadrant have competitive characteristics, but the company lags on time for completion.

Quadrant 4

In this quadrant technologies lag on all key parameters: quality and degree of technological readiness. However if the given technologies are in areas of national security and they are characterised by a high level of import dependence, an analysis of competitors and forced development may be necessary.

Recommendations about the further development of the companies are presented in Table 7 according to technological competencies of the company.

Table 7

Recommendations about the further development of the company in corresponding technological areas

№	Characteristics of technologies		Areas of technological competencies of company	Recommendations
	Advantages on characteristics in comparison with leaders	Advantages on development terms in comparison with leaders		
1	Essential advantages	Essential advantages	Area of priorities: advantages of company's technology on terms and characteristics	The analysis of the market for an estimation of perspectives for entry is required
2	Essential advantages	Advantages are absent	Area of advantages on quality (at backlog on terms in the same time)	Investments for the fostering the end of development cycles are required
3	Advantages are absent	Essential advantages	Area of advantages of "the first course" (at backlog under characteristics in the same time)	Investments for improvement of quality of technical characteristics of technology are required
4	Advantages are absent	Advantages are absent	Area of backlog from competitors on all key parameters	The analysis of competitors and estimation of a level of import-dependence are required

Source: authors' analysis.

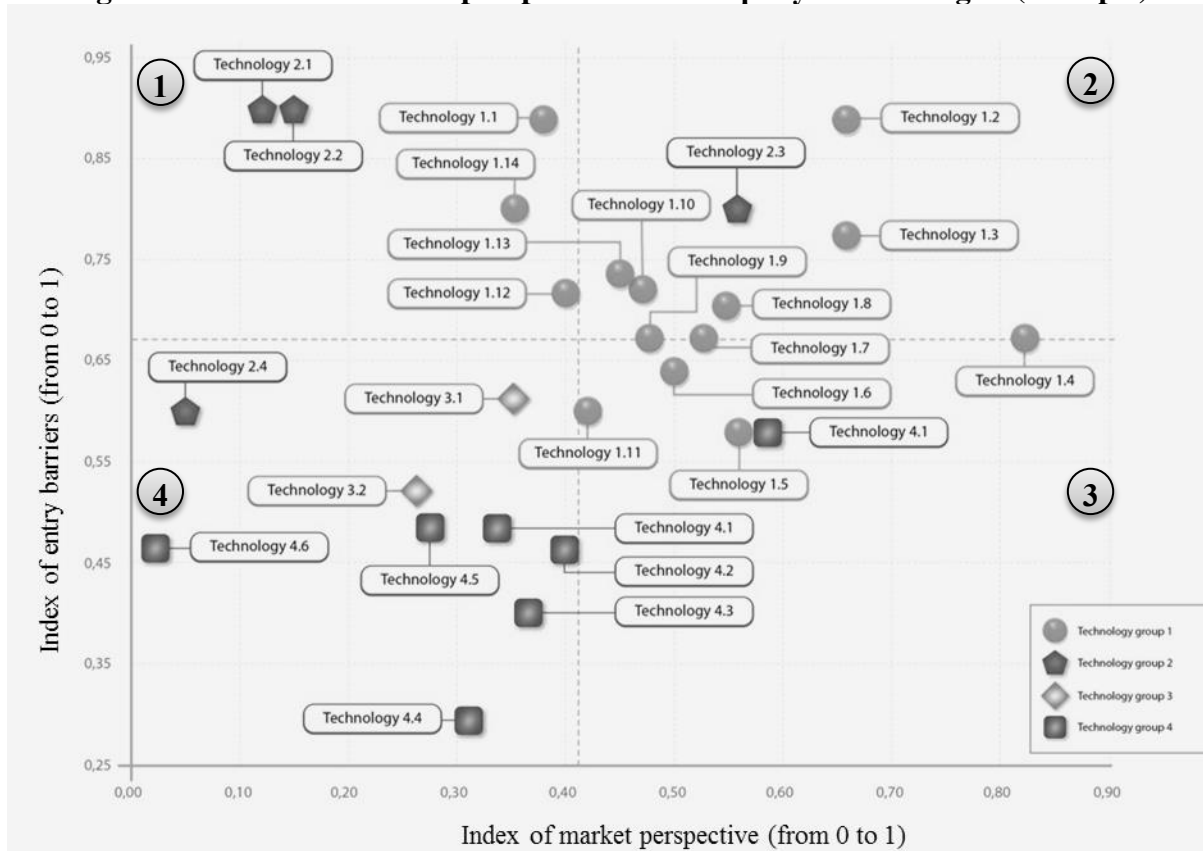
Estimation of market prospects

Identifying development priorities includes the analysis of the science and technological reserves of the company and their comparisons to the expected demand for such technologies. The analysis of prospects of the market takes into account their volumes, growth dynamics in the next 10–15 years, and entry possibilities to the market.

The results of the analysis of market prospects for the technologies are presented by matrix constructed in system of co-ordinates: values of the market prospects index and the barrier to entry index. The market prospects index corresponds to the BCG approach to market analysis. This characterizes the volume of the markets—larger markets have higher priority—and it reflects the growth potential of the market, measured by the expected rates of its dynamics. For the barrier to entry index, the closer the value of this indicator to 1, the lower the barriers of entry and the closer the value is to 0 the higher the entry barriers.

All technologies are divided into four groups according to level of market prospects of the technology. The results of grouping of technologies are illustrated in Fig. 2.

Fig. 2 Estimation of market prospects of the company's technologies (example)



Source: authors' analysis.

Note: the matrix is divided into 4 quadrants according to the median values of the index of market perspective and the index of entry barriers.

Quadrant 1

This quadrant groups the technologies which can be commercialized in small markets having limited growth potential. However in view of low entry barriers such markets can be interesting to the company in the case of high scientific and technological reserves in the corresponding technological areas.

Quadrant 2

This quadrant includes the most prospective market segments. Revealing large and fast-growing markets with low barriers to entry.

Quadrant 3

Quadrant 3 includes those market segments with limited entry opportunities. The possible solution is technological cooperation with organisations having stronger positions in these markets.

Quadrant 4

Given quadrant includes the markets with small volumes, low growth rates and high barriers to entry. This group has low commercialisation prospects because of high market risks.

Recommendations about the further development of the activity of the organisation are presented in Table 8 according to the identified areas of market perspective of company's technologies.

Table 8

**Recommendations about the further development of the company
in corresponding technological areas**

№	Market characteristics		Areas of market perspective of company's technologies	Recommendations
	Market dynamics in the next 10–15 years	Entry market opportunities		
1	High	High	Large and fast-growing markets, high opportunities for entry market	Priority funding
2	High	Low	Large and fast-growing market, opportunities for entry market are limited	Possible technological co-operation with organizations with stronger competitive position. It requires analysis of competitors
3	Low	High	Small markets, high opportunities for entry market	Due to low entry barriers technology commercialization is possible. It requires an assessment of the technological capabilities of the company
4	Low	Low	Area of high market risks	It requires further evaluation of the market and analysis of potential consumers of technologies and competitors

Source: authors' analysis.

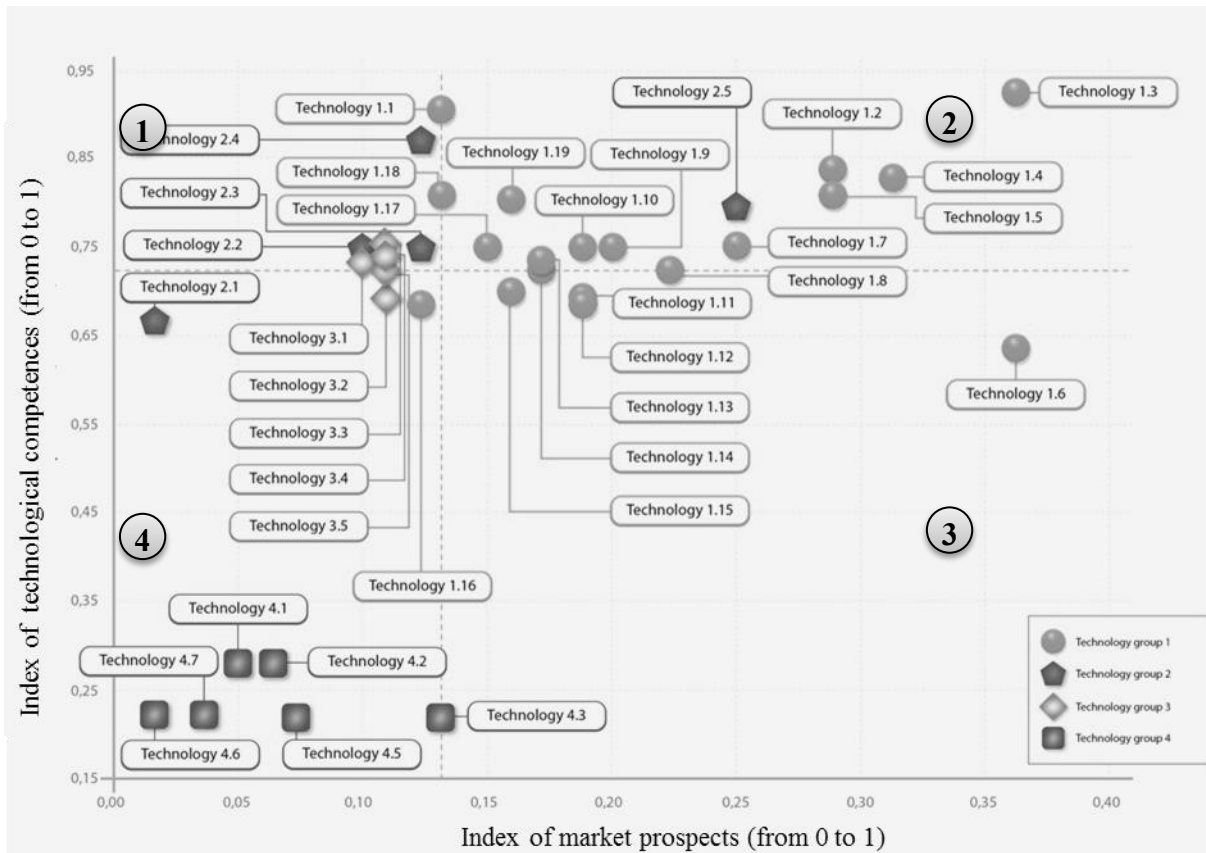
Assessment of the opportunities of the scientific and technological capacity of the company

The assessment of these opportunities is made on the basis of the results of the joint analysis of factors of a market demand and the technological supply.

In Fig. 3 the integrated index of market prospects for each area shows the characteristics of demand factors—market size, its expected dynamics and lack of entry barriers. The integrated index of the technological competences which characterizes the advantages of the technologies from the point of view of their characteristics and the expected commercialization time.

As above the technologies are divided into four groups according to the estimates of these opportunities. The results of group of technologies are illustrated in Fig. 3.

Fig. 3 Assessment of opportunities of use of scientific and technological capacity of the company (example)



Source: authors' analysis.

Note: the matrix is divided into 4 quadrants according to median values of an integrated index of market prospects and an integrated index of technological competences.

Quadrant 1

The first quadrant includes the technologies having competitive advantages — quality and time of completion. However market risks for this group of technologies are high because of insufficient demand and/or the high level of the competition.

Quadrant 2

In the second quadrant there are the technologies combining a high level of scientific and technological reserves with considerable potential demand.

Quadrant 3

This quadrant includes technologies where a gap in their expected satisfaction is characteristic.

Quadrant 4

The further development of technologies from this quadrant is hampered because of high technological and market risks.

Recommendations for the further development according to the quadrants are presented in Table 9.

Table 9

**Recommendations about further development of activity
in the corresponding areas of activity of the company**

№	Characteristics of supply and demand on development		Area of a combination of scientific and technological reserves of the company and market potential of its technologies	Recommendations
	Scientific and technological reserves	Market demand		
1	High	High	Priority areas: high market potential is combined with considerable scientific and technological reserves	Commercialization of technologies
2	High	Low	Existence of scientific potential is combined with high market risks	Demand stimulation is required
3	Low	High	Gap between market needs and technological capabilities	Considerable investments into technological development are required
4	Low	Low	Area of high technological and market risks	A detailed assessment of benefits of entry markets is required

Source: authors' analysis.

CONCLUSION

The proposed methodology to assess the prospects and prioritise the development of technologies can be readily used by high tech companies. The implementation of this matrix approach allows companies to make strategic decisions regarding the further implementation of technology projects. The advantage of this approach is that it considers a large number of criteria characterizing the level of scientific and technological reserves, and criteria related to market characteristics. In future research we intend to concentrate on including a new criterion into the model reflecting how the priorities of companies match the priorities of science and technological development in Russia. This task is relevant to the issue of the development of import-replacement.

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Anastasia Edelkina

Junior Research Fellow, [Research Laboratory for Science and Technology Studies](#), International Research and Educational Foresight Center, Institute of Statistical Sciences and Economics of Knowledge. Corresponding author. Email: aedelkina@hse.ru

Oleg Karasev

Deputy Director, International Research and Educational Foresight Center, Institute of Statistical Sciences and Economics of Knowledge. Email: okarasev@hse.ru

Marina Klubova

Research Fellow, International Research and Educational Foresight Center, Institute of Statistical Sciences and Economics of Knowledge, Higher School of Economics. Email: mklubova@hse.ru

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