DOI: 10.17747/2618-947X-2021-3-202-211

Toolkit for selecting technology as a transfer object under multi-criteria conditions

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Abstract

The article analyzes the features of the development of small and medium-sized enterprises (SMEs) in the context of the COVID-19 pandemic. There revealed the negative trends associated with the disproportionality of the sectoral structure of the business and the low enterprises' innovative activity. The key measures of state support for entrepreneurship taken by the Government of the Russian Federation in the period 2020–2021 are considered. The expediency of stimulating small and medium-sized businesses to participate in the process of technology transfer is determined, based on which the main purpose of the study is formulated, associated with the formation of economic and mathematical tools for choosing a technology for further implementation in the practice of SMEs. The research substantiates the expediency of using the fuzzy-multiple simplified method of analysis of hierarchies by Saaty for choosing technological solutions from a finite number of available alternatives, taking into account the interests of small and medium-sized businesses. The proposed approach makes it possible to increase the degree of validity of management decisions by reducing the volume of metamathematical operations and reducing the impact of subjectivism.

Keywords: small and medium business, government support, transfer, technology, multicriteria, choice, hierarchy analysis method.

For citation:

Kravchenko S.I., Meshkov A.V., Kiseleva A.I. (2021). Toolkit for selecting technology as a transfer object under multi-criteria conditions. *Strategic Decisions and Risk Management*, 12(3): 202-211. DOI: 10.17747/2618-947X-2021-3-202-211. (In Russ.)

Introduction

In the context of the crisis phenomena in the economy associated with the next wave of the spread of COVID-19, the very possibility of business entities survival directly depends on their ability to adapt to dynamically changing conditions, produce and disseminate ideas aimed at offsetting the impact of the negative consequences of market changes, as well as their willingness to become recipient of new technologies in business. To a large extent, this applies to representatives of small and medium-sized enterprises (SMEs), since the negative consequences of the pandemic have affected the vast majority of companies in this sector. As a result of surveys conducted by the Commissioner for the Protection of the Rights of Entrepreneurs under the President of the Russian Federation, in 2020, a drop in demand affected 80% of SMEs, while so far demand has not recovered in 52.6% of them, and turnover, according to Rosstat for 2020 year decreased by 3.1 trillion rubles. in comparison with the previous period[1].

In the context of the recession, the state took unprecedented measures to support business: for example, 42% of entrepreneurs received state support, which made it possible to compensate for the sharp drop in demand in the second quarter of 2020. However, the demand growth trend was interrupted at the end of 2020, and already in the first quarter of 2021, this indicator fell by 13%[2], that is, with the end of state support programs, the situation of small and medium-sized businesses worsened again. It is quite obvious that in such a situation, the need to introduce innovative

[1] SME/Post-Covid. Time for system solutions: Special report of the Commissioner under the President of the Russian Federation for the Protection of the Rights of Entrepreneurs to the President of the Russian Federation. 2021. URL: http://doklad.ombudsmanbiz.ru/2021/7.pdf.
[2] Id.

technologies that can ensure the sustainable development of business entities is uncontested.

Based on previous author's research [Kravchenko, Kvilinskiy, 2016; Kravchenko, 2019; Kravchenko, Zanizdra, 2019], given the large number of studies by foreign scientists conducted in this area [Lee et al., 2012; Bozeman et al., 2015; Gunsel, 2015; Kumar et al., 2015; Hsu et al., 2017; Aleinikova et al., 2020; Leal, 2020; Becker, Becker, 2021; Estep et al., 2021], and also taking into account that in the conditions of unstable demand, as well as limited resources, the issues of increasing the degree of validity of management decisions are being updated (especially in terms of choosing the best options for further development), the purpose of this work is to propose a toolkit for choosing a technology as an object of transfer for its further implementation in the practice of SME activity based on a comparative assessment of available technological solutions (under conditions of multi-criteria).

1. Description of the research methodology

In fact, the choice of the optimal technology option for its subsequent implementation is a decision-making process in a multi-criteria environment. At the same time, there is a fairly wide range of relevant methods and approaches, which in the most general form can be reduced to three main groups (Table 1).

The proposed classification is not exhaustive and only characterizes the individual methods analyzed in the work to determine the most suitable for the purposes of choosing the optimal technology. At the same time, among the considered approaches, of particular interest is the method of analysis of hierarchies by T. Saati (hereinafter MAI) [Saati, 1989], which is designed to solve multicriteria problems with a finite set of possible alternatives and criteria for their selection. Its application is based on expert information about the relative importance of the criteria in the form of a pairwise comparison matrix.

It should be noted that T. Saaty's hierarchy analysis method has qualitative advantages over others, since it allows you to flexibly vary the number and composition of criteria, as well as take into account the characteristics of technologies that have both quantitative and verbal assessment. However, its procedure is significantly complicated by the complexity of pairwise comparisons, especially with a significant number of alternatives (as in the case of the technology selection problem), and the need to check the pairwise comparison matrices for compatibility. These shortcomings are eliminated by using the simplified AHP proposed in the work of V.D. Nogin [Nogin, 2004].

Another significant drawback of this method is a high degree of subjectivity, due to the fact that when choosing a technology, estimates are used that are given by one or more experts by prior agreement, which reduces their objectivity. This effect can be leveled by using the methodological base of the theory of fuzzy sets [Artamonov et al., 2016].

2. Theoretical and calculated parts

According to the main provisions of the national project "Small and Medium Enterprises and Support for Individual Entrepreneurial Initiative", the development of SMEs is one of the strategic goals of the Russian Federation. This

Table 1
Description of the main methods for solving multicriteria problems

Group	Name	Characteristics
Reduction to one criterion	Principal criterion method	It is assumed that from the point of view of the decision maker, one of the criteria (the main one) has a significantly higher priority than all the others, but with one important caveat: according to the other criteria, the option should not be too bad either
	Convolution method	It is supposed to introduce some generalized criterion, which is a function on a set of individual indicators (the generalized criterion allows you to sort the alternatives by value and select the best among them - additive, multiplicative, maximin convolutions)
Reaching a compromise between criteria	The method of successive concessions	All private criteria are arranged and numbered in order of their relative importance, then the criteria are gradually maximized in descending order of their importance, taking into account the established value of the allowable decrease in the value of the higher criterion (the optimal strategy is usually considered to be any strategy that is obtained when solving the problem of finding the conditional maximum of the last criterion in importance)
Ranking criteria according to their degree of significance	Hierarchy analysis method	It involves a phased solution of the following interrelated particular tasks: – construction of a hierarchical structure of indicators (features); – assessment of the significance of individual private indicators for each level of the hierarchy; – comparison of available alternatives and selection of the best one

Source: compiled by the authors based on [Saati, 1989; Nabatova, 2020; Podinovsky, 2019].

document is aimed at improving the business climate, as well as increasing the role of this kind of business in the economy (for the period 2019-2024) and provides an increase in the number of people employed in the SME sector up to 25 million people, an increase in the share of this sector of the economy up to 32.5% in GDP and up to 10% in the total volume of non-commodity exports[3]. The achievement of the set strategic targets is complicated by the negative consequences of COVID-19. Thus, according to preliminary estimates, the share of SMEs in the GDP of the Russian Federation in 2020 decreased by 1% compared to the previous period and amounted to 19.8%. At the same time, the number of people employed in the sector recovered to the level of 2018 and increased from 26% in 2019 to 27% in 2020. However, experts note the risk of a decrease in this indicator if there is no need to maintain the number of employees under the terms of support. Small and medium-sized enterprises turned out to be the most sensitive to the negative impact of the pandemic due to their high concentration in those sectors of the economy that have experienced significant changes in the volume and structure of market demand and supply (in the Russian Federation, the largest share of SMEs is involved in wholesale and retail trade, and this figure increased from 34.8% in 2018 to 41% in 2020)[4, 5]. Businesses are facing key challenges such as falling revenues, supply disruptions, communication difficulties, increasing uncertainty and, as a result, financial instability.

Taking into account the fact that small business is the basis of the population well-being, creating a significant number of jobs and smoothing the effects of social stratification in society, the state faces with an urgent need to develop effective measures to support this sector of the economy. Thus, the Government of the Russian Federation has taken a number of measures to support small and medium-sized businesses engaged in the areas of activity most affected by the deteriorating situation due to the spread of coronavirus infection. The mechanisms of financial, property, information and consulting support have been implemented. Studies of the effectiveness of state support measures for SMEs confirm the satisfactory result of the actions taken, pointing to the significant awareness of business entities about the programs being implemented and the high intensity of applications.

It is characteristic that most of the proposed measures are aimed at compensation of unavoidable losses and do not allow realizing such an indisputable advantage of small businesses as mobility and flexibility, readiness for rapid adaptation in quickly changing business conditions and reorientation of activities. It should be noted that the Concept of long-term socio-economic development of the Russian Federation by 2020 provided for a reduction in the share of small businesses employed in the trade sector and an increase in the number of SMEs in the field of information services, science, housing and communal services and, most importantly, healthcare[6]. Thus, a rational state policy in the field of small business support should stimulate structural changes in this sector and an increase in the number of SMEs employed in priority sectors.

The results of a number of Russian and international studies make it possible to single out such topical areas of activity as preventing the spread of infections, diagnosing a disease, evaluating large amounts of information, adapting to quarantine and self-isolation conditions, and high-tech developments. At the same time, research and development is being carried out in Russia and abroad in these innovative areas of activity, financed both at the expense of the state budget and private investors.

In such conditions, the issues of stimulating technology transfer are updated, which, according to GOST R 57194.1-2016, is a process of technology transfer and the corresponding rights to it from the transferring party to the receiving party for the purpose of subsequent implementation and use, and the process of technology transfer itself includes such stages as:

- identification of the need for technology, on the one hand, and the object of sale, on the other;
- assessment of the costs associated with the acquisition of technologies;
- information search;
- comparative analysis, assessment of the level of readiness and choice of technology;
- negotiations between the seller and the buyer of technology;
- conclusion of an agreement and transfer of technology (or other result of intellectual activity);
- use of technology and monitoring of results[7].

The current legislation defines the category "technology" as the result of scientific and technical activity expressed in an objective form, which includes inventions, utility models, industrial designs, computer programs or other results of intellectual activity subject to legal protection in accordance with current legislation, and can serve as a technological basis for certain practical activities in the civil or military sphere[8]. A number of works emphasize the expediency of considering technology as a commodity, which should have such properties as science intensity and the presence of competitive advantages in comparison with other available technologies [Mrykhina, 2018].

Thus, the crisis conditions for the functioning of SMEs create the preconditions for realizing the need for a constant search for new technologies, which determines the importance of ensuring free access of recipients to information about current innovative technologies, the possibility of

[3] Passport of the national project "Small and Medium Enterprises and Support for Individual Entrepreneurial Initiatives" (approved by the Presidium of the Council under the President of the Russian Federation for Strategic Development and National Projects, protocol dated December 24, 2018 No. 16). URL: https://www.economy.gov.ru/material/file/65c7e743dffadf1f3f3a8207e31a0d99/Passport_NP_MSP.pdf.
[4] Small and medium business in Russia. 2019: Statistical compendium. Moscow: Rosstat, 2019.
[5] SME/Post-Covid. Time for system solutions…
[6] On the Concept of long-term socio-economic development of the Russian Federation for the period up to 2020: Decree of the Government of the Russian Federation of November 17, 2008 No. 1662-r // Consultant Plus. URL: http://www.consultant.ru/document/cons_doc_LAW_82134/28c7f9e359e8af09d7244d8033c66928fa27e527/.
[7] GOST R 57194.1-2016. Technology transfer. General provisions. Introduction. 2017.05.01. M.: Standartinform, 2020.
[8] Id.

obtaining financial support necessary for organizing the introduction of innovations. In addition, the transfer of technology developed at the expense of the state budget can be considered as one of the tools of state support for business.

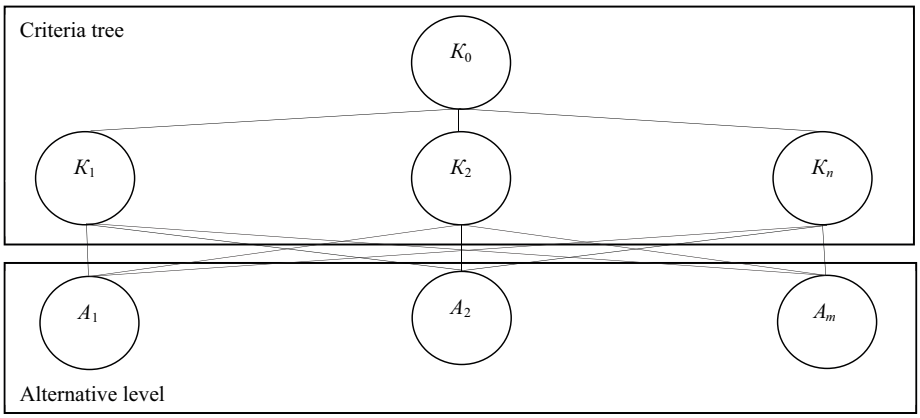
The state digital business support platform "My Business" provides business entities with access ршто consolidated information on the procurement system, available banking products and guarantees, educational programs, financial, property, consulting, information and innovation support programs, including the catalog of franchises, most of which are concentrated in the service sector. However, the platform lacks a database of technological profiles, that is, requests and proposals for technical and technological solutions adapted to the specifics of small business representatives. This information can be accessed on the SME Business Navigator Portal, as well as on the Russian Technology Transfer Network Portal.

In the context of a lack of real experience and professional skills in the implementation of innovative projects, small businesses face a number of obstacles to the introduction of new technologies, starting from the moment of justifying the choice of a project that can best meet the interests of a business entity and satisfy the existing financial, labor and technical constraints. Thus, the development of an effective method for choosing technical, technological and other solutions for their further implementation in the practice of small enterprises is an urgent scientific task and deserves special attention.

In this paper, in order to select the optimal technology, it is proposed to perform the following sequence of actions:

- Determining the current goals of the SME entity, the achievement of which should contribute to the implementation of technology;
- establishing a list of technological solutions that can be applied under a specific business entity;
- Formation of a group of experts whose opinions will be taken into account when making decisions;
- substantiation of the list of technology selection criteria;
- carrying out each expert in pairwise comparison of existing technologies for each decision criterion;
- submission of generalized results of expert assessments of all involved specialists in the form of fuzzy numbers;
- assessment of the existing alternatives according to hierarchy analysis method;
- Formulation of conclusions on the choice of optimal technology in order to further implement the activities of the enterprise based on the criterion for the maximization of the assessment obtained as a result of the calculations.

Fig. 1. Hierarchy of the technology choice problem



Where K_0 – main goal of technology selection;

$K_1, K_2, \ldots, K_n$ – technology evaluation ctiteria

$A_1, A_2, \ldots, A_m$ – technologies that can be implemented by a business entity.

Source: compiled by the authors based on [Saaty, 1989].

In accordance with the hierarchy analysis method of the hierarchy (graph of a special form), the problem of selecting technology for SMEs will have the following form (Fig. 1).

According to fig. 1 the achievement of the main goal indicated K_0, that is, the choice of the optimal technology is completely determined by the achievement of the criteria (K_1, K_2, ..., K_n). The role of each criterion in achieving the main goal is different, which is reflected in the assignment of different weighting factors to them. In this case, the weight of the main goal is equal to the sum of the weight indicators of the criteria. Determining the final set of evaluation criteria depends on the specifics of the business entity, its strategic goals and characteristics of business conditions. However, in the most general form, they can be classified into the following groups:

- consumer characteristics of goods or services resulting from the introduction of technology;
- analysis of the potential market (size, growth dynamics, main segments, difficulties in entering the market);
- assessment of the competitive environment;
- degree of technology readiness;
- legal protection of the idea;
- availability of resources.

At the level of alternatives (A_1, A_2, ..., A_m), there are points that characterize the options for technologies that can be introduced into the practice of a small enterprise. Lines connecting alternatives to criteria indicate that technologies should be analyzed in terms of their degree of compliance with the criteria.

Thus, having determined the weight of each criterion relative to the main goal, and then the weight of each technology from the position of each criterion, it is possible to determine the weight of each technology already from the position of the main goal, using hierarchical weighting operations:

$$Bec(A^i) = Bec(A^i/K_1) \cdot Bec(K_1) + Bec(A^i/K_2) \cdot Bec(K_2) + ... + Bec(A^i/K_n) \cdot Bec(K_n), \quad (1)$$

Where i – the number of alternative.

The technology with the greatest weight from the position of the main goal will be optimal [Saati, 1989].

Let's say a small business decides to purchase a franchise from among those recommended on the My Business platform, using the list of criteria mentioned above. At the same time, at the preliminary stage of selection, four franchises were admitted for consideration, each of which involves the provision of technical and technological services to the population, individuals and legal entities, which coincides with the scope of a small enterprise (in order not to disclose information related to the features of each franchise option, and not violate the copyrights of their owners, we will conditionally call them technology 1, 2, 3 and 4, respectively). To make a decision, a small enterprise formed a group of experts, including both employees of the enterprise and third-party specialists. In this case, the hierarchy of the franchise selection problem can be represented as a graph in Fig. 2.

For the value of the weight of the alternative relative to the main goal, it is first necessary to determine the weight of each decision-making criterion with respect to it by the expert method, and then set the weight of each technology in relation to each criterion.

The expert needs to conduct a series of pairwise comparisons of alternatives, determining on a nine-point scale (Table 2) a quantitative assessment that will indicate the relative advantage of one alternative over another.

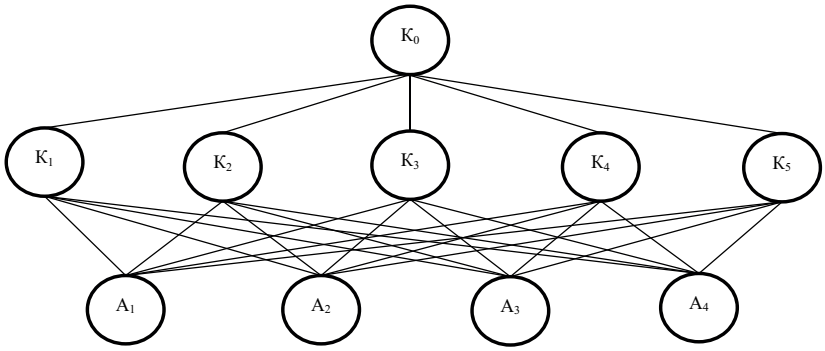
Table 2
Ratio scale

Extent of importance	Definitions	Explanations
1	Equal importance	Both objects contribute equally to the achievement of the goal.
3	Weak importance	Slight advantage of one object over another
5	Essential importance	Significant advantage of one object over another
7	Obvious importance	The advantage of one object over another is very strong
9	Absolute importance	The advantage of one object over another is more than obvious
2, 4, 6, 8	Intermediate values	Intermediate level between designated states

Source: [Saati T., 1989].

The quantitative result of pairwise comparisons of criteria from the point of view of the main goal is presented in the form of a matrix of pairwise comparisons with dimension $n \times n$: $G_K = (K_{ij})$, $(i, j = 1, 2, ..., n)$.

Fig. 2. Hierarchy of the problem of choosing a technology for an enterprise



Source: developed by the authors based on [Saati, 1989].

For the presentation of expert assessments, it is proposed to use the apparatus of the theory of fuzzy sets, which will minimize the risk of error from subjectivity. According to the theory, expert opinions can be represented as a fuzzy number $(L–R)$-type.

The fuzzy tolerance number $(L–R)$-type is characterized by the membership function presented in the formula (2):

$$\mu_A(x) = \begin{cases} L\left(\frac{a_1 - x}{\alpha}\right), a_1 - \alpha \le x \le a_1, \\ 1, a_1 \le x \le a_2, \\ R\left(\frac{x - a_2}{\beta}\right), a_2 \le x \le a_2 + \beta, \\ 0, \text{иначе.} \end{cases}, \quad (2)$$

where $[a_1; a_2]$ – is the $(L–R)$-type fuzzy tolerance number mode, α – is the left fuzziness coefficient, β – is the right fuzziness coefficient.

If we assume, that L and R of the membership function of the fuzzy numbers described above are represented by straight lines, then the $(L–R)$-type $A(a_1, a_2, \alpha, \beta)$ fuzzy tolerant number can be represented as a fuzzy trapezoidal number (fuzzy four) $B(b_1, b_2, b_3, b_4)$ so that:

$$\begin{cases} b_1 = a_1 - \alpha, \\ b_2 = a_1, \\ b_3 = a_2, \\ b_4 = a_2 + \beta. \end{cases} \quad (3)$$

Fuzzy number arithmetics is based on the principles of simple intervals.

In practice, the result of expert evaluation in the form of a fuzzy number is formed as follows: the expert evaluates the significance of one alternative in relation to another on a scale from Table. 2. Based on the results of a survey of all experts, a membership function is constructed that corresponds to a specific four of numbers, the meaning of which is as follows: the degree of significance of the alternative being evaluated

is in the range from b_1 to b_4, but most likely it is in the range from b_2 to b_3.

According to the hierarchy analysis method, the matrix of pairwise comparisons must meet the following requirements:

- All the elements of G_K matrix should not be negative: $a_{ij} > 0$ for all numbers $i, j = 1, 2, ..., n$;
- G_K matrix is antisymmetrical: $a_{ij} = \frac{1}{a_{ij}}$ for all numbers;
- G_K matrix is conjoint, that is equations $a_{ij} = a_{ik} \cdot a_{kj} = \frac{a_{kj}}{a_{ki}}$ have place for all numbers $i, j = 1, 2, ..., n$;
- n number is the maximum eigenvalue of the matrix G and for a single (normalized) column vector $W_K = (w_1, w_2, ..., w_n)^T$ with positive components an equation is done $G_K W_K = nW_K$.

Using the scheme of "comparison with a sample" (which is the first object of comparison), on the basis of the degree of advantage or lag of each object in relation to the first, quantitatively determined by experts, we will construct a matrix that satisfies all the specified conditions, for which we use formula 4:

$$a_{ij} = a_{i1} a_{ij} = \frac{a_{1j}}{a_{1i}}. \quad (4)$$

So, as a result of assigning quantitative estimates to the criteria for making a decision regarding the main goal, we get a fuzzy matrix of pairwise comparisons (Table 3).

This matrix needs to be defuzzified for further actions (Table 4).

Let us introduce a modified representative number [Akhrameyko et al., 2002]:

$$R(x) = \sum_{i=1}^{n} \left(r_i \cdot \frac{x_1^{a_i} + x_2^{a_i}}{2} \right) = \sum_{i=1}^{n} \left(\frac{1}{\sum i} \cdot \frac{x_1^{a_i} + x_2^{a_i}}{2} \right), \quad (5)$$

Where $R(x)$ – modified representative number, $\left(x_1^{a_i}, x_2^{a_i}\right)$ – i-th α-slice, r_i – is the weight coefficient of the i α-slice, i – is the number of the α-slice, n – is the number of α-slices.

The ranking of alternatives (construction of the priority vector) is based on the main eigenvector of the defuzzified matrix of pairwise comparisons.

Based on the simplified method of hierarchy analysis proposed by Nogin [Nogin, 2004], it can be argued that the eigenvector of the defuzzified matrix G_K will consist of the components of the last column of the pairwise comparison matrix normalized to the sum of these elements. This vector will be equal $W_K = (0{,}53;\ 0{,}17;\ 0{,}13;\ 0{,}1;\ 0{,}07)^T$.

Since the matrix is built according to the method of comparison with the sample, it initially meets all the requirements and does not need to be checked for consistency. But for additional verification of the accuracy of calculations, you can define the indicator of the consistency ratio (*OC*) as the ratio of the consistency index (*HC*) to the number corresponding to the random consistency of the matrix of the same order in percent. The consistency ratio should not exceed 20%. The consistency index is determined by formula (6):

Table 3
Matrix of pairwise comparisons of decision criteria

Criterion	K_1 – financial characteristics of the project	K_2 – consumption characteristics of goods and services	K_3 – the analysis of potential market	K_4 – resource security	K_5 – degree of technology readiness and legal protection of the idea
K_1 – financial characteristics of the project	(1; 1; 1; 1)	(2; 3; 4; 5)	(3; 4; 5; 6)	(4; 5; 6; 7)	(6; 7; 8; 9)
K_2 – consumption characteristics of goods and services	$\left(\frac{1}{5}; \frac{1}{4}; \frac{1}{3}; \frac{1}{2}\right)$	(1; 1; 1; 1)	$\left(\frac{3}{5}; 1; 1\frac{2}{3}; 3\right)$	$\left(\frac{4}{5}; 1\frac{1}{4}; 2; 3\frac{1}{2}\right)$	$\left(1\frac{1}{5}; 1\frac{3}{4}; 2\frac{2}{3}; 4\frac{1}{2}\right)$
K_3 – the analysis of potential market	$\left(\frac{1}{6}; \frac{1}{5}; \frac{1}{4}; \frac{1}{3}\right)$	$\left(\frac{2}{6}; \frac{3}{5}; 1; 1\frac{1}{3}\right)$	(1; 1; 1; 1)	$\left(\frac{2}{3}; 1; 1\frac{1}{2}; 2\frac{1}{3}\right)$	$\left(1; 1\frac{2}{5}; 2; 3\right)$
K_4 – resource technology	$\left(\frac{1}{7}; \frac{1}{6}; \frac{1}{5}; \frac{1}{4}\right)$	$\left(\frac{2}{7}; \frac{1}{2}; \frac{4}{5}; 1\frac{1}{4}\right)$	$\left(\frac{3}{7}; \frac{2}{3}; 1; 1\frac{1}{2}\right)$	(1; 1; 1; 1)	$\left(\frac{6}{7}; 1\frac{1}{6}; 1\frac{3}{5}; 2\frac{1}{4}\right)$
K_5 – degree of technology readiness and legal protection of the idea	$\left(\frac{1}{9}; \frac{1}{8}; \frac{1}{7}; \frac{1}{6}\right)$	$\left(\frac{2}{9}; \frac{3}{8}; \frac{4}{7}; \frac{5}{6}\right)$	$\left(\frac{1}{3}; \frac{1}{2}; \frac{5}{7}; 1\right)$	$\left(\frac{4}{9}; \frac{5}{8}; \frac{6}{7}; 1\frac{1}{6}\right)$	(1; 1; 1; 1)

Source: developed by the authors.

Table 4
Defuzzified matrix of pairwise comparisons of decision criteria

Criterion	K_1 – Financial characteristics of the project	K_2 – consumption characteristics of goods and services	K_3 – the analysis of potential market	K_4 – resource security	K_5 – degree of technology readiness and legal protection of the idea
K_1 – financial characteristics of the project	1.00	3.50	4.50	5.50	7.50
K_2 – consumption characteristics of goods and services	0.31	1.00	1.49	1.80	2.42
K_3 – the analysis of potential market	0.23	0.87	1.00	1.33	1.80
K_4 – resource security	0.19	0.69	0.88	1.00	1.44
K_5 – degree of technology readiness and legal protection of the idea	0.14	0.49	0.63	0.76	1.00

Source: developed by the authors.

Table 5
Matrix of pairwise comparisons of alternatives for each of the decision criteria

	A_1 – technology 1	A_2 – technology 2	A_3 – technology 3	A_4 – technology 4
K_1 *Criterion 1 «Financial characteristics of the project»*				
A_1 – technology 1	(1; 1; 1; 1)	$\left(\frac{1}{7};\frac{1}{6};\frac{1}{5};\frac{1}{4}\right)$	$\left(\frac{1}{9};\frac{1}{8};\frac{1}{7};\frac{1}{6}\right)$	$\left(\frac{1}{5};\frac{1}{4};\frac{1}{3};\frac{1}{2}\right)$
A_2 – technology 2	(4; 5; 6; 7)	(1; 1; 1; 1)	$\left(\frac{4}{9};\frac{5}{8};\frac{6}{7};1\frac{1}{6}\right)$	$\left(\frac{4}{5};1\frac{1}{4};2;3\frac{1}{2}\right)$
A_3 – technology 3	(6; 7; 8; 9)	$\left(\frac{6}{7};1\frac{1}{6};\frac{3}{5};2\frac{1}{4}\right)$	(1; 1; 1; 1)	$\left(1\frac{1}{5};1\frac{3}{4};2\frac{2}{3};4\frac{1}{2}\right)$
A_4 – technology 4	(2; 3; 4; 5)	$\left(\frac{2}{7};\frac{1}{2};\frac{4}{5};1\frac{1}{4}\right)$	$\left(\frac{2}{9};\frac{3}{8};\frac{4}{7};\frac{5}{6}\right)$	(1; 1; 1; 1)
K_2 *Criterion 2 «Consumption characteristics of goods and services»*				
A_1 –technology 1	(1; 1; 1; 1)	$\left(\frac{1}{8};\frac{1}{7};\frac{1}{6};\frac{1}{5}\right)$	$\left(\frac{1}{7};\frac{1}{6};\frac{1}{5};\frac{1}{4}\right)$	(3; 4; 5; 6)
A_2 – technology 2	(5; 6; 7; 8)	(1; 1; 1; 1)	$\left(\frac{5}{7};1;1\frac{2}{5};2\right)$	(15; 24; 35; 48)
A_3 – technology 3	(4; 5; 6; 7)	$\left(\frac{1}{2};\frac{5}{7};1;1\frac{2}{5}\right)$	(1; 1; 1; 1)	(12; 20; 30; 42)
A_4 – technology 4	$\left(\frac{1}{6};\frac{1}{5};\frac{1}{4};\frac{1}{3}\right)$	$\left(\frac{1}{48};\frac{1}{35};\frac{1}{24};\frac{1}{15}\right)$	$\left(\frac{1}{42};\frac{1}{30};\frac{1}{25};\frac{1}{12}\right)$	(1; 1; 1; 1)
K_3 *Criterion 3 «The analysis of potential market»*				
A_1 – technology 1	(1; 1; 1; 1)	(4; 5; 6; 7)	(5; 6; 7; 8)	$\left(\frac{1}{8};\frac{1}{7};\frac{1}{6};\frac{1}{5}\right)$
A_2 – technology 2	$\left(\frac{1}{7};\frac{1}{6};\frac{1}{5};\frac{1}{4}\right)$	(1; 1; 1; 1)	$\left(\frac{5}{7};1;1\frac{2}{5};2\right)$	$\left(\frac{1}{56};\frac{1}{42};\frac{1}{30};\frac{1}{20}\right)$
A_3 – technology 3	$\left(\frac{1}{8};\frac{1}{7};\frac{1}{6};\frac{1}{5}\right)$	$\left(\frac{1}{2};\frac{5}{7};1;1\frac{2}{5}\right)$	(1; 1; 1; 1)	$\left(\frac{1}{64};\frac{1}{49};\frac{1}{36};\frac{1}{25}\right)$
A_4 – technology 4	(5; 6; 7; 8)	(20; 30; 42; 56)	(25; 36; 49; 64)	(1; 1; 1; 1)
K_4 *Criterion 4 «Resource security»*				
A_1 – technology 1	(1; 1; 1; 1)	(5; 6; 7; 8)	(4; 5; 6; 7)	$\left(\frac{1}{9};\frac{1}{8};\frac{1}{7};\frac{1}{6}\right)$
A_2 – technology 2	$\left(\frac{1}{8};\frac{1}{7};\frac{1}{6};\frac{1}{5}\right)$	(1; 1; 1; 1)	$\left(\frac{1}{2};\frac{5}{7};1;1\frac{2}{5}\right)$	$\left(\frac{1}{72};\frac{1}{56};\frac{1}{42};\frac{1}{30}\right)$
A_3 – technology 3	$\left(\frac{1}{7};\frac{1}{6};\frac{1}{5};\frac{1}{4}\right)$	$\left(\frac{5}{7};1;1\frac{2}{5};2\right)$	(1; 1; 1; 1)	$\left(\frac{1}{63};\frac{1}{48};\frac{1}{35};\frac{1}{24}\right)$
A_4 – technology 4	(6; 7; 8; 9)	(30; 42; 56; 72)	(24; 35; 48; 63)	(1; 1; 1; 1)
K_5 *Criterion 5 «Degree of technology readiness and legal protection of the idea»*				
A_1 – technology 1	(1; 1; 1; 1)	$\left(\frac{1}{7};\frac{1}{6};\frac{1}{5};\frac{1}{4}\right)$	(1; 2; 3; 4)	(3; 4; 5; 6)
A_2 – technology 2	(4; 5; 6; 7)	(1; 1; 1; 1)	(4; 10; 18; 28)	(12; 20; 30; 42)
A_3 – technology 3	$\left(\frac{1}{4};\frac{1}{3};\frac{1}{2};1\right)$	$\left(\frac{1}{28};\frac{1}{18};\frac{1}{10};\frac{1}{4}\right)$	(1; 1; 1; 1)	$\left(\frac{3}{4};1\frac{1}{3};2\frac{1}{2};6\right)$
A_4 – technology 4	$\left(\frac{1}{6};\frac{1}{5};\frac{1}{4};\frac{1}{3}\right)$	$\left(\frac{1}{42};\frac{1}{30};\frac{1}{25};\frac{1}{12}\right)$	$\left(\frac{1}{6};\frac{2}{5};\frac{3}{4};1\frac{1}{3}\right)$	(1; 1; 1; 1)

Source: developed by the authors.

Table 6
Defuzzified matrix of pairwise comparisons of alternatives for each of the decision criteria

	A_1 – technology 1	A_2 – technology 2	A_3 – technology 3	A_4 – technology 4
K_1 *Criterion 1 «Financial characteristics of the project»*				
A_1 – technology 1	1.00	0.19	0.14	0.31
A_2 – technology 2	5.50	1.00	0.72	1.80
A_3 – technology 3	7.50	1.44	1.00	2.42
A_4 – technology 4	3.50	0.69	0.49	1.00
K_2 *Criterion 2 «Consumption characteristics of goods and services»*				
A_1 – technology 1	1.00	0.16	0.19	4.50
A_2 – technology 2	6.50	1.00	1.25	30.17
A_3 – technology 3	5.50	0.89	1.00	25.67
A_4 – technology 4	0.23	0.04	0.04	1.00
K_3 *Criterion 3 «The analysis of potential market»*				
A_1 – technology 1	1.00	5.50	6.50	0.16
A_2 – technology 2	0.19	1.00	1.25	0.03
A_3 – technology 3	0.16	0.89	1.00	0.03
A_4 – technology 4	6.50	36.67	43.17	1.00
K_4 *Criterion 4 «Resource security»*				
A_1 – technology 1	1.00	6.50	5.50	0.14
A_2 – technology 2	0.16	1.00	0.89	0.02
A_3 – technology 3	0.19	1.25	1.00	0.03
A_4 – technology 4	7.50	49.67	42.17	1.00
K_5 *Criterion 5 «Degree of technology readiness and legal protection of the idea»*				
A_1 – technology 1	1.00	0.19	2.50	4.50
A_2 – technology 2	5.50	1.00	14.67	25.67
A_3 – technology 3	0.49	0.10	1.00	2.40
A_4 – technology 4	0.23	0.05	0.63	1.00

Source: developed by the authors.

$$ИС = \frac{\lambda \max - n}{n - 1}, \quad (6)$$

Where λ_{max} – the maximum eigenvalue of the matrix, n – is the order of the matrix.

For the matrix of pairwise comparisons (Table 4), the consistency ratio is 5.65%.

Similarly, vectors of matrices of pairwise comparison of alternative technologies are found in relation to each of the decision criteria (Table 5) (that is, vectors W_{K_1}, W_{K_2}, …, W_{K_n} matrices G_{K_1}, G_{K_2}, …, G_{K_n} respectively).

Further in Table 6, the matrices of pairwise comparisons of alternative technologies are defuzzified according to the selected list of criteria for their evaluation.

The priority vectors of alternatives obtained for the above matrices will have the following form: $W_{K_1} = (0{,}06; 0{,}31; 0{,}43; 0{,}20)^T$, $OC_{K_1} = 5{,}41\%$; $W_{K_2} = (0{,}07; 0{,}49; 0{,}42; 0{,}02)^T$, $OC_{K_2} = 2{,}25\%$; $W_{K_3} = (0{,}13; 0{,}02; 0{,}02; 0{,}83)^T$, $OC_{K_3} = 1{,}90\%$; $W_{K_4} = (0{,}11; 0{,}02; 0{,}02; 0{,}85)^T$, $OC_{K_4} = 1{,}85\%$; $W_{K_5} = (0{,}12; 0{,}78; 0{,}07; 0{,}03)^T$, $OC_{K_5} = 4{,}08\%$.

The next step is to determine the vector of alternatives with respect to the main goal as the result of multiplying the matrices, which consist of the vectors W_{K_1}, W_{K_2}, …, W_{K_n} to the vector W_K:

$$W = [W_{K_1} W_{K_2} \ldots W_{K_n}] \cdot W_{K_n}. \quad (7)$$

As a result of multiplication, we get a vector $W_{K_1} = (0{,}080; 0{,}311; 0{,}309; 0{,}301)^T$.

The technology that corresponds to the largest element of the resulting vector is considered optimal. That is, in the analyzed situation, technology 2 can be chosen as the best.

Conclusion

The study analyzed key negative trends in the development of small and medium-sized businesses in the Russian Federation, including those related to the consequences of the coronavirus pandemic, as well as government support measures taken in 2020-2021. The expediency of creating conditions for the participation of business entities in the processes of technology transfer is substantiated. As a result, the paper proposes a method for selecting technologies for further implementation in the practice of small enterprises, based on the use of a simplified method for analyzing Saati hierarchies, modified by using fuzzy number tools to fuzzify expert judgments. This approach allows the enterprise to form a reasonable economic decision while reducing the volume of metamathematical operations and reducing the influence of subjectivism.

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The article was submitted on 28.09.2021; revised on 2.10.2021 and accepted for publication on 5.11.2021. The authors read and approved the final version of the manuscript.