European Journal of Contemporary Education
E-ISSN 2305-6746
2024. 13(1): 292-304
DOI: 10.13187/ejced.2024.1.292
https://ejce.cherkasgu.press

Model for Assessing Strategic Development Alternatives for the Workforce Advanced Training System in a Single-Industry Town, Taking Into Account Neurodidactic Principles

Alexandra A. Zakharova [a], Vladislav G. Lizunkov [b, *], Marina V. Morozova [b],
Otabek M. Gaybullayev [c]

[a] Tomsk State University of Control Systems and Radioelectronics, Tomsk, Russian Federation
[b] National Research Tomsk Polytechnic University, Tomsk, Russian Federation
[c] Samarkand state institute of foreign languages, Samarkand, Uzbekistan

Abstract

Today, one of the priority directions of modern education is the use of various methods to improve the quality of educational events. Authors argue that education based on neurodidactic principles helps prepare highly qualified workers for specific tasks in a short period and maintains learners' interest in continuing their education.

The goal of this study is to develop a decision-making model for choosing a strategy for the development of the workforce advanced training system in the conditions of labour market imbalances in a single-industry town and high uncertainty of the labour market's future needs.

In the theoretical aspect, a model for assessing strategic development alternatives for the workforce advanced training system of a single-industry town has been developed, providing information for decision-making.

In the practical aspect, the generation and evaluation of development alternatives for the specific WATS of a single-industry town have been carried out, taking into account the features of its strategy and development.

For preliminary processing of expert assessments and calculations using the AHP method, the LibreOffice Calc spreadsheet editor was used.

As a result of the research, a new approach to assessing and selecting strategic alternatives for the development of the workforce advanced training system of a single-industry town has been proposed, considering the role of the workforce development system as a crucial element of the municipality's The proposed model takes into account the features of the networking of WATS and high uncertainty in decision-making.

[*] Corresponding author
E-mail addresses: vladeslave@rambler.ru (V.G. Lizunkov), zacharovaa@mail.ru (A.A. Zakharova), morozovamv@tpu.ru (M.V. Morozova), ogaybullaev1979@gmail.com (O.M. Gaybullayev)

Keywords: single-industry town, workforce advanced training system, neurodidactics, network cooperation, strategy, analytic hierarchy process.

1. Introduction

In the last decade, there has been a reevaluation of the role, goals, and tasks of education on the international level as one of the factors for sustainable global development. In 2015, the United Nations General Assembly adopted the resolution "Transforming Our World: The 2030 Agenda for Sustainable Development" (United Nations General Assembly, 2015). One of the 17 global sustainable development goals in this resolution is "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all." Concerning vocational education, this goal implies providing access to quality vocational and higher education for the population, significantly increasing the number of individuals with skills in demand for employment, decent work, and entrepreneurship.

The development and specification of pathways to achieve this goal were carried out in 2022 during the UNESCO World Conference on Higher Education (May 18-20, Barcelona), where a roadmap for rethinking and developing higher education worldwide was adopted (UNESCO, 2022). Additionally, UNESCO developed a strategy for transforming secondary education and vocational training in 2022. The education system of the future is expected to be flexible, quickly adaptable to the needs of individuals, the economy, and society as a whole, introducing new formats for implementing educational programs and ensuring access to education throughout life. Furthermore, institutions of vocational education are expected to bear social responsibility, produce well-rounded professionals capable of solving complex problems, and contribute to the sustainable development of municipalities, regions, and countries.

Document (UNESCO, 2022) emphasizes the importance of developing strategies for skills enhancement and retraining of the workforce, as well as fostering collaboration between educational institutions, the government, and businesses. The need for developing such strategies is also highlighted in another goal of Resolution (United Nations General Assembly, 2015), which focuses on ensuring the openness, security, resilience, and ecological sustainability of cities and settlements. Addressing the issue of aligning the professional potential of the population with the demands of the labour market requires comprehensive situational analysis, planning, and decision-making.

The problems of social and economic development of single-industry towns in the Russian Federation require active state intervention and the formation of additional measures of state support and tools to develop and implement a strategy (Crowley, 2016). The magnitude of the task stems from a large number of single-industry towns and the diversity of their conditions – in the Russian Federation there are currently 321 settlements with the status of a single-industry town (single-industry municipal formation) (Order of the Government…, 2020). Assessment of single-industry towns by two factors – directions of migration flows and levels of production location – is proposed to form alternatives for a single-industry town development (Shastitko, Fatikhova, 2019). As a result, four alternatives were identified: diversification of industries, independent innovative and technological development of a town which economy is dominated by a single industry or company, liquidation and artificial maintenance of the single-industry town.

Each option suggests different approaches to the formation of a single-industry town strategy: creation of special economic zones - priority development areas (Ulitskaya et al., 2017), ensuring population mobility (Anikieva, 2020), creating conditions for attracting qualified specialists to township-forming enterprises (Nekrasova, 2012), etc. We should note that irrespective of the single-industry town strategy, the most important resource for a single-industry town is the population, and, accordingly, the main task is to provide employment for the able-bodied population. In this regard, an effective advanced training system plays a major role in the successful implementation of a single-industry town development strategy, which should provide the current and expected needs of the single-industry town labour market, as well as the implementation of the educational path and professional careers of individual members of the population (Shirshov, 2017). This makes the issue of a strategy for the development of a single-industry town workforce advanced training system (WATS) a topical one.

One of the key tools of WATS is the application of neurodidactic principles. Neuro didactics is an applied neuroscience which focuses on the use of cognitive neurology, psychology, differential psychophysiology, and neuropsychology, and uses data on the ways brain manages processes of mastering different types of learning material. It also studies issues of students and teachers' IPL

(Individual Profile of Lateration) compatibility. Neurodidactics is based on the fundamentals of pedagogy, psychology, neuroscience, cybernetics, and reflects a person-centered approach in education.

Neurodidactics aims at solving pedagogical problems efficiently and with a good amount of creativity. Here, it is necessary to know how the brain of each individual percepts and processes information; thus, what the peculiarities of their higher cognitive functions are. (Westerhoff, 2008) It focuses on the results that research works in brain and neurobiology bring to the issues of learning and memory; thus, make them useful for pedagogy and didactics. Didactic principles and recommendations for learning and teaching that are not harmful to the brain are based on the knowledge about structure, development, and functioning of the brain (Politsinskaya et al., 2023).

Based on the studies of scientists who have made a significant contribution to the development of neurodidactics, with M. Arnold, W. Hartmann, U. Kraft among them (Lizunkov et al., 2023), we formulated ten principles of neurodidactics that we applied in WATS. In our opinion, these principles become basic for an effective training when we need to train people to perform specific operations or tasks in a short time period of time. The principals are the following:

- students should have an opportunity to obtain specific experience while training (for this purpose we should provide cooperation between educational institutions and employers to identify and implement the most important practical tasks into the education institution curriculum as soon as they help obtain and develop practical competencies);
- training becomes efficient when it includes real social situations (in this context, the development of extra professional as well as cultural competences, which are necessary for further socialization of people at work, will occur during the advanced training);
- training becomes more efficient when educators take into account individual interests and ideas of students. Here, learning motivation and further professional guidance play a key role in making students efficient at work;
- training becomes more efficient when theoretical knowledge and practical experiences that students have already obtained are mobilized (it is necessary to assess students' competences before they start training and offer a program that will help them develop their competencies up to the new professional level, and get new ones in a short period of time);
- when positive emotions are engaged, training also becomes more efficient (emotional well-being of students and methods that help educators create positive and healthy learning environment are important factors that support effective and fast acquisition of new information and skills);
- acquisition of new information and skills becomes more intense when learning environment is appropriate for students and teachers (i.e. the kind of an environment that contributes to a faster perception of new information and its assimilation);
- training also gets efficient when there is time for reflection (students need time to process the information they receive; they need to understand what they are doing, how they are going to use it, and what else they can do acquire the full information or to learn how to perform better);
- training goes on better when students can link learning materials to practical experience (theory and practice combination is an important matter that helps develop practical skills with students);
- training is more efficient when students' personalities and individual abilities and talents are taken into account by educators (methods which help determine lateralization, enhance learning and increase assimilation of learning and training content) (Arnold, 2009).

In our opinion, it is necessary to add neurodidactic principles to WATS alternatives development. Neurodidactic instruments will help optimize advanced training and will accelerate it.

Subject of research

Single-industry town WATS needs to be formed considering the interests of the main actors of labour and education markets in a single-industry town: administration of a single-industry town, employers, educational institutions, population of the town (Zakharova et al., 2020). The objectives of these actors may be different (Lizunkov et al., 2021). The literature review (Zakharova et al., 2020) revealed the importance of organizing networking between the main actors of training as an essential condition for the effectiveness of the training system. This process is particularly important for single-industry towns, as they are the most acutely linked to the results of WATS and the opportunities to diversify the single-industry town economy, move away from single-industry, reduce the brain drain from the city, and therefore retain the population. We should also note that the Covid-19 pandemic has had a huge impact on increasing the number of remote jobs, which also enhances the importance of networking by providing both training and employment processes for the single-industry town population with new opportunities.

The main task in forming a workforce training system at any level is to forecast the needs of national and regional economies for personnel (Shrestha, 2024). Existing forecasting models are often based on balancing expected labour market needs and workforce supply (Vankevich, Castel-Branko, 2017). This involves collecting information from employers and educational institutions (Sparreboom, Powell, 2009); information on possible scenarios of technological and socio-economic development of the whole country and its regions (Gurtov et al., 2016); analyzing demographic situations in territories (Vasilyeva, 2017), population migration trends and rates (Ostapchuk et al., 2021), and other indicators. Mathematic methods and software that are currently used to forecast labour market needs aim at the meso- and macro-levels; and they do not take into account social and economic specificity of single-industry towns.

Besides forecasting a level of workforce rate, an equally important task for a single-industry town is to develop ways of overcoming staff imbalance in the labour market. The causes of staffing imbalances can include:

- mismatch between the quantitative and vocational qualification structure of labour market supply and demand;
- liquidation of enterprises that have a significant impact on the labour market of a single-industry town;
- migration of the population, usually highly qualified and competitive in the labour markets of other cities and regions, and other reasons.

The high uncertainty of these and other developments in a single-industry town impedes the construction of reliable models of labour market needs in the medium and long term (Zakharova et al., 2020). However, this is the horizon that matters for the training system, so the problem of selecting strategic directions for developing the ATS of single-industry towns does not have adequate tools to solve it.

The subject of our study is the development of a decision-making model that provides the processes of strategizing the development of the advanced training system of a single-industry town in the conditions of network cooperation of actors to eliminate the imbalance in the labour market of a single-industry town. In the article, the term 'strategy' refers to the long-term qualitatively defined direction for the development of a single-industry town's ATS.

2. Methodology

The proposed model for assessing strategic alternatives for WATS development in a single-industry town covers two stages:

1. Generating strategic development alternatives;
2. Evaluating alternatives in view of the importance of network cooperation between the main actors: single-industry town authorities, employers, educational institutions and local residents.

To generate strategic development alternatives we suggest using an “educational institution-labour market” (EI-LM) matrix, which studies two major features of WATS:

- where to train personnel (educational institutions (EI) of a single-industry town; external educational institutions located outside the territory of the single-industry town) – these alternatives can be seen in matrix’s lines;
- who will consume training (train personnel for prospective labour market needs of a single-industry town itself or train them for the needs of employers outside the single-industry town providing vacancies for remote and shift work) - these alternatives can be seen in matrix’s columns.

At the intersection of lines and columns of the matrix, possible alternatives for the development of a single-industry town with one of the four combinations of characteristics are presented:

Quadrant I. Alternatives aimed at developing the capacity of educational institutions of a single-industry town to develop and implement relevant educational programs and modern pedagogical methods, with the main objective to meet current and future possible needs of a single-industry town labour market.

Quadrant II. Alternatives that also develop capabilities of educational institutions of a single-industry town, but the main task of implemented programs and methods is to satisfy professional and career interests of single-industry town residents by focusing on current and future possible needs of a single-industry town labour market.

Quadrant III. Alternatives that aim to expand educational opportunities for local residents at external educational institutions, i.e. those that are located in other regions, but have relevant education programs and use modern education techniques. At the same time, programs and methods outcomes of these institutions should meet current and future possible needs of a single-industry town labour market.

Quadrant IV. Alternatives aim to use resources and educational potential of external educational institutions and satisfy employment demands of single-industry town residents in the context of the external labour market.

Alternatives can be formulated at the junction of quadrants, respectively; can prioritize either residents, or authorities, or educational institutions, or employers.

Next step is to assess generated strategic alternatives in terms of the impact they produce on the objectives of networking actors and the WATS target state achievement. This decision-making task has a hierarchical structure: it allows us to identify the relationships between the individual elements, but lacks information about the type of relations between them. For example, in WATS it is possible to identify actors interested in it (residents, educational institutions, etc.) and arrange cooperation between them; determine each actor's goals and find consistency or inconsistency in their goals; generate possible WATS development alternatives and determine ways they might correlate with the actors' goals. However, it is difficult to find clear unambiguous (mathematical) relations between all the factors due to the incompleteness and inaccuracy of available information as well as high uncertainty of the decision-making environment. In addition, a type of dependence will differ for various combinations of factors. All this requires the use of expert knowledge and judgment to assess and select the best alternatives (Rogachev, 2017).

In this regard, we chose the analytic hierarchy process (AHP) (Saaty, Vargas, 2022) as a method for assessing alternative development strategies for WATS. This method allows us to carry out a consistent decomposition of the problem to be solved on several grounds and obtain assessment of alternatives priorities, considering assessment of task elements at different levels of decomposition.

Standard levels of decomposition are usually distinguished as follows (from top to bottom):

- hierarchy focus - the main goal to be achieved;
- actors – those who influence the goal and/or are interested in it;
- actors' goals – goals that the actors want to achieve with respect to the hierarchy focus;
- scenarios (projects, alternatives) – ways, methods and actions used to achieve the main goal.

Decomposition results in hierarchy that appears on these levels. The hierarchy consists of a set of parent and child elements. For example, actors are parent elements for the goals on the one hand, and children elements for the hierarchy focus on the other hand.

Next, a method of hierarchy analysis involves performing sequential procedures of expert assessment of the importance of child elements in relation to the parent ones. After that, calculations of priorities are carried out. Values of these calculations allow identifying the most important alternatives in terms of achieving the main goal (focus), the interests of actors and their private goals.

The following provides a brief description of applying the AHP in the model of assessing strategic alternatives for the development of the advanced training system of a single-industry town in the conditions of network cooperation between the actors. Detailed descriptions of the AHP are given, for example, in (Saaty, Vargas, 2022) and examples of use for education in (Wang et al., 2021).

Stage 1. Presenting the problem as a hierarchy. This is a hierarchical model for assessing strategic alternatives for the development of the ATS:

Level 1 Hierarchy focus (S_o). The main goal is to eliminate the imbalance in the labour market of a single-industry town.

Level 2 Actors of ATS (S). The main stakeholders with objectives that are determinant for the ATS are the following: the town administration, the population, employers, and educational institutions (Zakharova et al., 2020).

Level 3 Actors' objectives (A). There are 2-5 objectives related to the development of the ATS for each actor. We propose to use the criteria of network effectiveness proposed in (Lizunkov et al., 2021) as a basis for identifying the objectives of actors

Level 4 Alternative strategies for the development of a single-industry town WATS (P). They are formulated according to the current situation in the labour market and education and the development strategy of a single-industry town (Li, 2021).

Stage 2. Constructing matrices of pairwise comparisons. An expert compares the elements of each level (excepting the focus) with respect to the parent element of the higher level (elements S are compared with respect to S_o, A – with respect to S, P – with respect to A). The comparison is made in pairs on the basis of the Saaty importance scale (Saaty, Vargas, 2022), which determines the dominance ratio of one item over another (scale values from 1 – equal importance, to 9 – very strong dominance, and inverse values from 1/9 to 1). The result is a set with expert ratings of the importance of the elements in the hierarchy (when they are compared in pairs).

Number of required matrices of pair wise comparison is determined by the number of parent elements on all levels of hierarchy.

Stage 3. Calculating local priorities. Expert assessment is used to calculate local priority vectors in the pair wise comparison matrices. For this purpose the values of elements of an eigenvector V are calculated first. For an i-th element V_i is calculated by formula (1):

$$V_i = \sqrt[n]{\prod_{j=1}^{n} a_{ij}} \qquad (1)$$

where a_{ij} is the value of a matrix element;

$i = \overline{1,n}$, $j = \overline{1,n}$ – numbers of matrix lines and columns, respectively;

n – number of elements.

Vector of local priorities is calculated by normalizing values of elements of the eigenvector by formula (2).

$$LP_i = \frac{V_i}{\sum_{i=1}^{n} V_i}, \qquad (2)$$

where LP_i is the i-th element of a local priority vector.

This results in local calculated values for the importance of actors (V_S), actors' objectives (V_A), and WATS strategies (V_P).

Stage 4. Checking the consistency of the results obtained. It serves to check if the matrix is completed correctly by the expert. There are a homogeneity index (HI) and a homogeneity ratio (HR). If the HR<0.1, then the expert's judgements are ordered and the results of the assessment can be used to make decisions.

Homogeneity index is determined by formula (3):

$$HI = (\lambda_{max} - n) \,/\, (n-1) \qquad (3)$$

where λ_max is the largest eigenvalue of the matrix, calculated by formulas (4), (5):

$$\lambda_{max} = \sum_{i=1}^{n} \lambda_i \,, \qquad (4)$$

$$\lambda_i = \sum_{i=1}^{n} a_{ij}\, LP_i \qquad (5)$$

The homogeneity ratio by formula (6):

$$HR = \frac{HI}{RR} \qquad (5)$$

where RR is the random homogeneity of the matrix (determined from the table for a given value of n) (Saaty, Vargas, 2022).

Stage 5. Calculating global priorities. To calculate global priority of a hierarchy element, we multiply local priorities of the lower-level elements by a global priority of the parent element of the higher-level element. If there are several parent elements, we find the sum of the weighted priorities for all parent elements. The result represents calculated values of V_S, V_A, V_P relative to the focus of the hierarchy as a whole. The best alternative will be the one with the highest global priority value. The decision-maker (the DM) can set a threshold for global priority, which allows selecting a set of recommended strategic directions.

Stage 6. The best alternative will be the one with the highest global priority value. The decision maker (DM) can set a threshold value of global priority, according to which the set of recommended strategic directions is selected.

For preliminary processing of expert assessments and calculations using the AHP method, the LibreOffice Calc spreadsheet editor was used, which is part of the LibreOffice office suite with a sufficient number of built-in functions to work with matrices and other mathematical operations.

3. Results and discussion

Model Application and Result Analysis

Based on the proposed hierarchical model, we have assessed and selected strategic alternatives for WATS development on the example of a single-industry town in the Russian Federation. Analysis of the development strategy of this single-industry town until 2035 (Strategiya sotsial'no-ekonomicheskogo..., 2021), as well as data from its social and economic development report for 2022 (Socialno-ekonomicheskoye..., 2021) allowed us to formulate the following limitations when choosing a development strategy for WATS:

- imbalance in the labour market caused by the closure of the town-forming enterprise, whereby it is not possible to rapidly create new jobs in the town and, accordingly, there is no possibility to clearly define necessary structure of professional training;

- education institutions are mainly oriented towards the industry of a town-forming enterprise, i.e. there are few employment opportunities among graduates. As a consequence, college and university graduates move to other cities. School leavers also tend to move to other cities to continue their education;

- a single-industry town has Priority Social and Economic Development Area (PSEDA) status, but to attract new employers and create new job opportunities is a distant prospect.

As a result of the system analysis of the situation, a hierarchy of strategy selection was developed. The names of the elements of the hierarchy are presented in column 2 of Table 1, and their symbols are presented in column 1 of the same Table. The graphical representation of the hierarchy, using the notations introduced in Table 1, is shown in Figure 1.

The hierarchical model has four levels:

Level 1. Hierarchy focus – Elimination of imbalance in the labour market (represented by a single element a0).

Level 2. Actors of cooperation in a single-industry town WATS (represented by elements a1-a4).

Level 3. The goals of subjects of network cooperation in a single-industry town WATS (represented by elements a5-a16).

Level 4. Alternative development strategies of a single-industry town WATS (represented by elements a17-a20).

Alternative strategic directions for the development of the WATS (a17-a20) have been formulated as follows:

a-17 – to organize targeted training that is focused at neurodidactic principles at external (territorial) higher education institutions and colleges, with training areas corresponding to the current and prospective needs of the town' employers (positioned in quadrant III in EI-LM matrix);

a-18 – to organize professional training at internal educational institutions after the pool of educational programs, which include neurodidactic principles, will have been reformed to meet the prospective needs of enterprises (including potential investors) (positioned in quadrant I in EI-LM matrix);

a-19 – to organize professional training at internal educational institutions, reformatting the pool of educational programs, which include neurodidactic principles, to accommodate out-of-town employment opportunities with residence in the town (remote or itinerant work) (positioned in quadrant II in EI-LM matrix);

a-20 – to provide training in business skills at internal/external training institutions, followed by business start-ups both within and outside the town (positioned at the intersection of quadrants I-IV in EI-LM matrix).

The expertise was conducted by professionals in the field of advanced training of personnel for businesses and industries that are located in the territories of advanced social and economic development and by the participants of the working group which aim is to develop a WATS strategy for single-industry towns.

As a result, 17 matrices of pair wise comparison were obtained:

- one matrix that includes expert assessment of actor dominance relative to the focus;
- four matrices include expert assessment of goal dominance relative to their actor;
- twelve matrices include expert assessment of the dominance of alternatives relative to each goal.

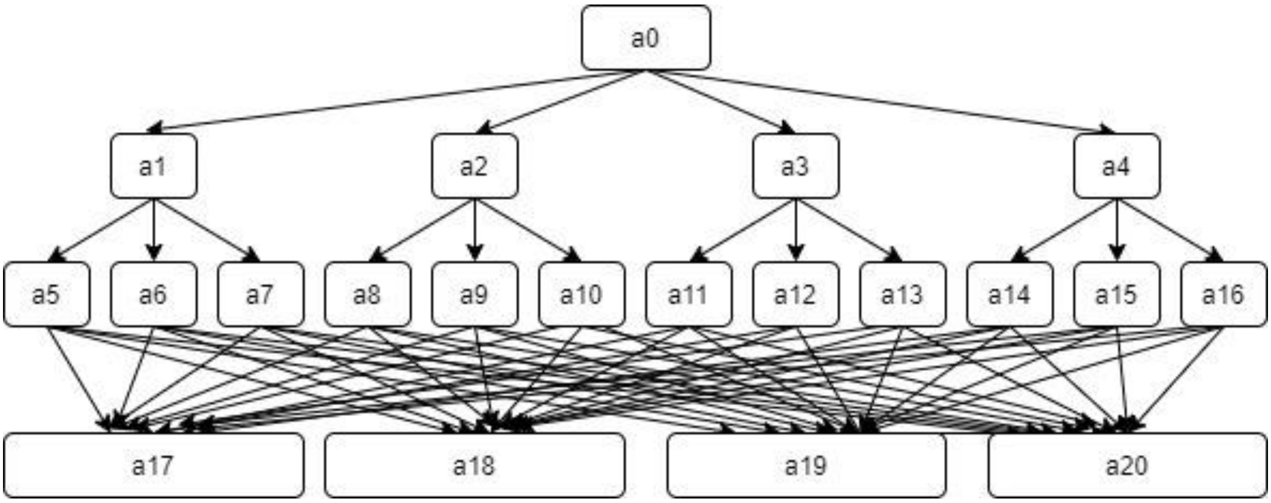

Fig. 1. Structure of development strategy selection hierarchy

Table 1. Results of calculations by a method of hierarchy analysis

Designation	Name of a hierarchy element	Priority	
		Local (LP)	Global (GP)
Hierarchy focus (primary objective)			
a0	Eliminating imbalances in the labour market	1	1
Networking actors in a single-industry town WATS			
a1	Authorities	0.600	0.600
a2	Employers	0.045	0.045
a3	Residents	0.228	0.228
a4	Educational institutions	0.127	0.127
Objectives of the networking actors in a single-industry town WATS			
a5	Reduction of unemployment	0.691	0.415
a6	Reduction of population outflow	0.133	0.080
a7	Raising of living standard of residents	0.176	0.106
a8	Attracting highly qualified professionals	0.076	0.003
a9	Filling vacant jobs	0.566	0.025
a10	Enterprise development	0.358	0.015
a11	Improving quality of life	0.196	0.045
a12	Expanding employment opportunities	0.740	0.169
a13	Comfort of the urban environment	0.064	0.015
a14	Demand for educational programs	0.079	0.010
a15	Strengthening relations with employers	0.435	0.055
a16	Increasing rates of graduates employment	0.486	0.062
Alternative strategies for a single-industry town WATS development			
a17	Targeted training at external educational institutions to fill vacancies in the single-industry town labour market	there are no (48 local priority values - 12 for each element)	0.488
a18	Training in a single-industry town for the domestic labour market		0.107
a19	Training in a single-industry town territory for remote or itinerant work		0.220
a20	Training focused on learning to build business skills		0.185

An example of the matrices of pairwise comparisons for a second-level hierarchy with expert additions and calculated local priorities is shown in Table 2.

Table 2. Matrices of pairwise comparisons of actors with respect to the hierarchy focus «Eliminating imbalances in the labour market»

Actors	Authorities	Employers	Residents	Education institutions	Eigenvector, V_i	Local Priority, LP_i
Authorities	1	7	4	6	3,6	0,600
Employers	0,143	1	0,143	0,25	0,267	0,045
Residents	0,25	7	1	2	1,368	0,228
Education institutions	0,167	4	0,5	1	0,76	0,127

Eigenvector elements were calculated by formula (1). For example:

$$V_1 = \sqrt[4]{\prod_{j=1}^{4} a_{1j}} = \sqrt[4]{1 \cdot 7 \cdot 4 \cdot 6} \approx 3{,}6$$

Local priorities were calculated by formula (2), for example:

$$LP_1 = \frac{V_1}{\sum_{i=1}^{4} V_i} = \frac{3{,}6}{3{,}6+0.267+1{,}368+0.76} \approx 0.600$$

Homogeneity index was determined by formula (3):

$$HI = (\lambda_{max} - 4) \,/\, (4 - 1) = (4{,}243 - 4) \,/\, (4 - 1) = 0{,}081$$

where λ_max was calculated by formula (4):

$$\lambda_{max} = \sum_{i=1}^{4} \lambda_i = 0{,}937 + 0{,}847 + 1{,}287 + 1{,}172 = 4{,}243\,,$$

where λ_i was calculated by formula (5), for example λ_1:

$$\lambda_1 = \sum_{i=1}^{4} a_{i1} * V_1^{norm} = (1 + 0{,}143 + 0{,}25 + {,}167) \cdot 0{,}6 \approx 0{,}937$$

The homogeneity ratio is determined by formula (6):

$$HR = \frac{HI}{RR} = \frac{0{,}081}{0{,}9} \approx 0{,}09$$

where RR=0.9 for a given value of n=4 according to source (Saaty, Vargas, 2022).

As the HR < 0,1, the expert's judgements are ordered and the results of the assessment can be used to make decisions.

The obtained values of local priorities shown in Table 1 prove the significance of the Authorities in eliminating imbalances in the labour market at the time of assessment (priority value is 0.600).

Calculated values of all local and global priorities were obtained, and in the paper they are presented in Table 1 (columns 3 and 4 respectively).

To calculate global priority of a hierarchy element, local priorities of the lower-level elements are multiplied by a global priority of the parent element of the higher-level element. When several parent elements occur, it is necessary to find the sum of the weighted priorities for all parent elements.

For example, global priority for element a5 «Reduction of unemployment» is calculated be formula:

$$GP_{a5} = LP_{a5} GP_{a1} = 0.691 \cdot 0.6 \approx 0.415$$

It is worth mentioning that the sum of global priorities equals one for all level elements, and the sum of local priorities equals one for all child elements for one of the parent elements. For example, the sum of local priorities for targets a5, a6, and a7 equals 1, since these three elements are the children of actor a1. This should be taken into account when interpreting the results.

The results allow us to draw the following conclusions. The highest priority in the current situation is strategy a17 "Organize targeted training that is focused at neurodidactic principles at external (territorial) higher education institutions and colleges, with training areas corresponding to the current and prospective needs of employers" (global priority 0.488). However, this considers the objectives of the Authority actor (a1) and the objective of reducing unemployment (a5) to the greatest extent. Targeted training will allow young people of the town to leave for training in other towns and get demanded professions in the labour market of the monotown, and at the same time, targeted training will bring young professionals back to the town. Next in priority are alternative strategies for training for remote work (a19) and entrepreneurial skills (a20), which also contributes to population retention and reduction of unemployment in the city. The alternative to organize vocational training at internal educational institutions to meet the prospective needs of the labour market and new potential employers-residents of the Priority Social and Economic Development Area (PSEDA) received the lowest priority. This is due to the inertia of the vocational education system and the considerable time required changing the structure of training areas in local professional education and training institutions.

The proposed model is a flexible decision-making tool that allows us to take into account changing decision-making conditions. At the same time, adaptation can be carried out in different ways and to different depths. Here are examples of conditions and corresponding changes in the model.

Only the main goal of a single-industry WATS strategy changes due to the transformation of basic direction of its development (for example, when the economic situation changes or when the importance of the main enterprise located in a town increases). In this case, a hierarchy structure may remain the same, but the change of focus will require new examination. This will result in the revision of priorities at each level of the hierarchy.

Actors might also change (new actors appear or number of actors reduces). In this case, it is necessary to revise links between the elements of the level being changed as well as its child and parent elements. For example, when a new actor (investor) is introduced, its goals should be identified, and the goals should be linked to the strategic development alternatives of WATS. New examination is required.

Goals of actors can be changed (be supplemented, reduced, or new ones might be introduced). In this case, it is necessary to revise connections between objectives and actors as well as between objectives and projects, and conduct a new expert assessment.

Strategic development alternatives may change (be supplemented, reduced, or new ones can be introduced). In this case, it is necessary to revise relations between goals and projects, and to conduct a new expert assessment.

Combination of the above mentioned conditions to adapting the model is possible.

When describing the importance of planning the development of the professional education sector, most researchers emphasize the significance of aligning with current and future labour market needs (Sparreboom, Powell, 2009). It is undisputed that the development of an individual's professional skills throughout their life should provide opportunities for decent employment and an improvement in the standard of living (Vankevich, Castel-Branko, 2017). Furthermore, there is a significant role attributed to the interaction between educational institutions and employers (Mahesh, Naitik, 2014). Some studies delve into additional labour market factors, such as the social and economic development of regions (Gurtov et al., 2016), regional demographics, and population migration (Vasilyeva, 2017). Issues related to labour market modeling for the purpose of developing development strategies and decision-making under uncertainty are also considered (Ostapchuk et al., 2021). Increasingly, it is recognized that the application of neurodidactic principles in workforce training is one of the key tools for their high-quality training in a short period of time.

In agreement with the findings of these studies, this research focuses on a combination of the aspects mentioned in them and new aspects, namely:

Formulating a development strategy for the workforce advanced training system as a crucial element of the municipality's strategy, aiming to enhance the quality of life and urban development sustainability.

Developing a decision-making model that facilitates the process of strategizing the development of the workforce advanced training system for a single-industry town within the context of network cooperation among WATS actors to address the labour market imbalance in the single-industry town.

Accounting for a high level of uncertainty in strategic decision-making.

As a result, new findings have been obtained, supporting the process of making strategic decisions in the development of workforce training system strategies. These findings can be applied not only to single-industry towns but also to other territorial units at the meso and micro levels of governance. The proposed model for evaluating strategic development alternatives for the advanced training system of workforce in a single-industry town offers tools for generating and assessing alternatives. The alternative generation phase is typically loosely formulated, and the matrix method proposed in the study allows to structure alternatives based on the key components of professional education: "educational institutions – labour market." Additionally, unlike existing approaches to WATS planning, the use of the Analytic Hierarchy Process (AHP) method enables the consideration of the interests of key stakeholders (town residents, town authorities, educational institutions, and employers) in the evaluation of WATS development alternatives, as well as the incorporation of any factors identified by other researchers and the utilization of expert knowledge to support decision-making.

From a mathematical perspective, the model has limitations on the number of level elements subordinate to a single parent element.

According to Saaty (Saaty, Vargas, 2022) it is only possible to evaluate alternatives efficiently when their number is $n \leq 9$ (which is related to human capabilities). If experts compare more than 9 alternatives simultaneously, their assessments will be incorrect.

For the hierarchy structure proposed in the paper, restrictions will be as follows: no more than 9 actors, no more than 9 goals for each of the actors, no more than 9 alternatives of strategic development. However, in the issues of strategic management, a larger number of actors, goals and development directions is usually not considered.

In terms of flexibility and the possibility of adapting the model to the problems of strategic development of the system of advanced training of a single-industry town, the model has no significant limitations because it allows changing the composition of actors, their goals and directions of development, as well as the structure of their interrelationships.

4. Conclusion

Thus, the model of assessing strategic alternatives for the development of the advanced training system in a single-industry town under the conditions of network cooperation between the actors provides DM with information about the priority of possible options of the WATS development strategy to eliminate the personnel imbalance in the labour market and to select the best strategy. The model makes it possible:

- to make a decision in uncertainty based on expert judgment;
- to consider the specificities of a single-industry town and its socio-economic development strategy when making decisions;
- to obtain information on the impact of the actors involved in the WATS on overcoming personnel imbalances;
- to apply neurodidactic principles to train highly qualified workers, that are able to perform employers' tasks, in a short period of time;
- to receive information on the prioritization of the objectives of the WATS actors;
- to receive information on the prioritization of options for the development strategy of the WATS in a single-industry town in relation to the objectives of the actors in the network.

The article presents an example of using the model to choose a development strategy for an advanced training system in a particular single-industry town under the conditions of imbalance in the labour market and high uncertainty of prospective labour market needs. The model can be adapted to other contexts by changing the elements of the hierarchy and the relationships between them.

5. Acknowledgements

The study was supported by the Russian Science Foundation grant No. 23-28-00046, https://rscf.ru/project/23-28-00046/

References

Anikieva, 2020 – *Anikieva, A.V.* (2020). Trudovaya mobil'nost' naseleniya monogorodov Sverdlovskoi oblasti [Labor mobility of people from the monotowns in sverdlovsk oblast]. *Monitoring Obshchestvennogo Mneniya: Ekonomicheskie i Sotsial'Nye Peremeny*. 5: 449-465. DOI: 10.14515/monitoring.2020.5.536 [in Russian]

Arnold, 2009 – *Arnold, M.* (2009). Brainbased learning and Teaching. In U. Herrmann. *Neurodidaktik: Grundlagen und Vorschläge für gehirngerechtes Lehren und Lernen*, pp. 182-195. [Electronic resource]. URL: https://www.researchgate.net/publication/265092161_Neurodidaktik_Grundlagen_und_Vorschlage_fur_gehirngerechtes_Lehren_und_Lernen

Crowley, 2016 – *Crowley, S.* (2016) Monotowns and the political economy of industrial restructuring in Russia. *Post-Soviet Affairs*. 32(5): 397-422. DOI: 10.1080/1060586X.2015.1054103

Gurtov et al., 2016 – *Gurtov, V.A., Garifullina, N.Y., Sigova, S.V.* (2016). Forecasting recruitment needs of the Russian economy: Qualitative aspects. *Studies on Russian Economic Development*. 27(1): 68-75. DOI: 10.1134/S1075700716010044

Li, 2021 – *Li, N.* (2021). A Fuzzy Evaluation Model of College English Teaching Quality Based on Analytic Hierarchy Process. *International Journal of Emerging Technologies in Learning*. 16(2): 17-20. DOI: 10.3991/ijet.v16i02.19731

Lizunkov et al., 2021 – *Lizunkov, V.G., Morozova, M.V., Zakharova, A.A.* (2021). Effectiveness criteria for interaction between the participants of the educational production cluster within PDA. *International Journal of Emerging Technologies in Learning*. 16(8): 252-260. DOI: 10.3991/ijet.v16i08.19505

Lizunkov et al., 2023 – *Lizunkov, V.G., Malushko, E.Y., Trofimov, A.V., Galitsky, A.I.* (2023). Razrabotka metodiki opredeleniya funktsional"noi asimmetrii mozga u studentov vuza [Development of a method for determining functional brain asymmetry in university students]. *Artium magister*. 23(1): 26-35. [Electronic resource]. URL: https://cyberleninka.ru/article/n/razrabotka-metodiki-opredeleniya-funktsionalnoy-asimmetrii-mozga-u-studentov-vuza (date of access: 10.10.2023). [in Russian]

Nekrasova, 2012 – *Nekrasova, E.V.* (2012). Optimization of internal migration as a mechanism for solving the problems of monotowns in sverdlovsk region. *Economy of Region*. 2: 315-320. DOI: 10.17059/2012-2-32

Order of the Government..., 2020 – Order of the Government of the Russian Federation of July 29, 2014, no. 1398-r (as amended on January 21, 2020) "On approval of the list of single-industry municipalities of the Russian Federation (single-industry towns)". [Electronic resource]. URL: https://legalacts.ru/doc/rasporjazhenie-pravitelstva-rf-ot-29072014-n-1398-r/#101269 (date of access: 29.10.2021).

Ostapchuk et al., 2021 – *Ostapchuk, A., Kustrich, L., Tranchenko, L., Botsula, O., Kolmakova, V., Patoka, I.* (2021). Modeling the labor market stability in conditions of uncertainty as a component of strategic management. *International Conference on Business and Technology*. Pp. 261-272. DOI: 10.1007/978-3-030-69221-6_19

Politsinskaya et al., 2023 – *Politsinskaya, E.V., Lizunkov, V.G., Malushko, E.Y.* (2023). Organizatsiya nauchno-issledovatel"skoi deyatel"nosti studentov tekhnicheskogo vuza s uchetom osobennostei myslitel"noi deyatel"nosti [Organization of scientific research activity of students at technical university, taking into account the features of cognitive activity]. *Inzhenernoe obrazovanie*. 33: 26-38. DOI:10.54835/18102883_2023_33_3 [in Russian]

Rogachev, 2017 – *Rogachev, A.F.* (2017). Two-level economic and mathematical model of monotown development on the basis of cognitive maps. *Integration and Clustering for Sustainable Economic Growth*. Pp. 339-345. DOI: 10.1007/978-3-319-45462-7_35

Saaty, Vargas, 2022 – *Saaty, T., Vargas, L.* (2022). The Analytic Hierarchy Process. [Electronic resource]. URL: https://www.researchgate.net/publication/362349026_The_Analytic_Hierarch y_Process

Shastitko, Fatikhova, 2019 – *Shastitko, A.E., Fatikhova, A.F.* (2019). Monogoroda Rossii: vozmozhnye varianty razvitiya [Company towns in Russia: some thoughts on development alternatives]. *E-journal public administration*. 76: 109-135. DOI: 10.24411/2070-1381-2019-10006 [in Russian]

Shirshov, 2017 – *Shirshov, E.V.* (2017). Informaciya. Nauka. Obrazovanie: sredstva, metody i tehnologii. Hronologicheskaya retrospektiva stanovleniya i razvitiya [Information. Science. Education: tools, methods and technologies. Chronological retrospective of formation and development]. Dictionary of key concepts and definitions: a training manual. M.: Izdatel'skii dom Akademii Estestvoznaniya, P. 138. [Electronic resource]. URL: https://elibrary.ru/download/elibrary_30099082_90514352.pdf [in Russian]

Shrestha, 2024 – *Shrestha, R.B.* (2024). Labor Market Information System: A Review of Some Practices. *Journal of Technical and Vocational Education and Training*. 18(1): 10-19. [Electronic resource]. URL: https://www.nepjol.info/index.php/tvet/article/view/62739/47357

Socialno-ekonomicheskoye..., 2021 – Socialno-ekonomicheskoye razvitie Yurginskogo raiona na 2020 god [Socio-economic development of the Yurginsky urban district for 2020]. [Electronic resource]. URL: https://www.yurga.org/deyatelnost/ekonomika/sotsialno-ekonomicheskoe-razvitie/files/SER_2020.pdf (date of access: 29.10.2021). [in Russian]

Sparreboom, Powell, 2009 – *Sparreboom, T., Powell, M.* (2009). Labour market information and analysis for skills development. Theo Sparreboom and Marcus Powell; International Labour Office, Employment Trends Unit, Economic and Labour Market Analysis Department. Geneva: ILO. [Electronic resource]. URL: https://www.researchgate.net/publication/296934211_Labour_market_information_and_analysis_for_skills_development

Strategiya sotsial'no-ekonomicheskogo..., 2021 – Strategiya sotsial'no-ekonomicheskogo razvitiya Yurginskogo gorodskogo okruga na period do 2035 goda [Strategy of socio-economic development of the Yurginsky urban district for the period up to 2035]. [Electronic resource]. URL: http://www1.yurga.org/pagedata/00000181/files/sser_2035.pdf (date of access: 29.10.2021). [in Russian]

Ulitskaya et al., 2017 – *Ulitskaya, N.Yu., Akimova, M.S., Kokoreva, T.P.* (2017). The territory of advancing socio-economic development as a factor of development of the territory and attractions for the resident. *Business Strategies*. 10(42): 12-16. DOI: 10.17747/2311-7184-2017-10-12-16

UNESCO, 2022 – Beyond Limits. New Ways to Reinvent Higher Education. Working document for the World Higher Education Conference. 18-20 May 2022. [Electronic resource]. URL: https://en.unesco.org/sites/default/files/whec2022-concept-note-en.pdf

UNESCO, 2022 – Transforming Technical and Vocational Education and Training for successful and just transitions. UNESCO strategy for TVET 2022-2029 [Electronic resource]. URL: https://unevoc.unesco.org/pub/unesco_strategy_for_tvet_2022-2029.pdf

United Nations General Assembly, 2015 – United Nations General Assembly. Resolution 70/1 "Transforming our World: The 2030 Agenda for Sustainable Development" on September 25, 2015. [Electronic resource]. URL: https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_RES_70_1_E.pdf

Vankevich, Castel-Branko, 2017 – *Vankevich, E.V., Castel-Branko, E.* (2017). Labour market information system and skills anticipation (LMIS): content and directions of formation in the republic of Belarus. *Belarusian Economic Journal*. 2(79): 73-92. [Electronic resource]. URL: http://edoc.bseu.by:8080/bitstream/edoc/74841/1/Vankevich_E.V..Kastel_Branko_E..pdf [in Russian]

Vasilyeva, 2017 – *Vasilyeva, Å.V.* (2017). Prognoz trudovoi migratsii, vosproizvodstva naseleniya i ekonomicheskogo razvitiya Rossii [The forecast of labour migration, reproduction of the population and economic development of Russia]. *Ekonomika regiona*. 3(3): 812-826. DOI: 10.17059/2017-3-14 [in Russian]

Wang et al., 2021 – *Wang, M., Zhang, Z., Xu, M.* (2021). Postgraduate Training Performance Evaluation Applying Weighting and Comprehensive Fuzzy Evaluation Methods. *International Journal of Emerging Technologies in Learning*. 16(01): 124-133. DOI: 10.3991/ijet.v16i01.18231

Westerhoff, 2008 – *Westerhoff, N.* (2008). Neurodidaktik auf dem Prüfstand. *Gehirn & Geist*. 12: 36-43. DOI: 10.1007/ s12269-016-0038-4

Zakharova et al., 2020 – *Zakharova, A.A., Grebenyuk, Y.V., Zakharov, L.Y.* (2020). Spetsifika i tekhnologiya sozdaniya informatsionnogo obespecheniya sistemy operezhayushchei podgotovki kadrov monogorodov – territorii operezhayushchego razvitiya [Specifics and development technology of information support of personnel advanced training system of single-industry – territories of advanced development]. *Informatizatsiya obrazovaniya i nauki*. 2(46): 162-180. [Electronic resource]. URL: https://elibrary.ru/item.asp?id=43766643 (date of access: 10.08.2023). [in Russian]