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Assessment of Efficiency of the Innovative Hub by Means of Algorithms of the Indistinct Output

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Abstract— **In article, reasons for feasibility of formation of an innovative hub are given in the Far Eastern Federal District of Russia, through collaboration of innovative, research and development and scientific and educational infrastructure of the region. The factors influencing overall performance of an innovative hub are considered. By means of mathematical simulation, the system of an indistinct output and the adaptive neuro and indistinct system of an output for assessment of efficiency of an innovative hub in case of the different amount of financing of the elements entering it were constructed. Based on theoretical researches expected quantitative results of activities of elements of a hub which were collocated to its efficiency expressed in points of 0-10 are revealed. Reasons for use of system of an indistinct output for determination of dependence of efficiency of an innovative hub on volume of the investments enclosed in it are result of operation.**

Keywords— Innovative hub; innovative ecosystem; system of an indistinct output; algorithms of an indistinct output; innovative development of the university; financing of innovative activities

I. INTRODUCTION

Widespread foreign practice when forming regional innovative ecosystems is creation of innovative hubs [1,2,3]. Similar network centers play a role of the hub [4] and include infrastructure of innovations, the technological companies, scientific educational institutions, customers of innovations, etc.

Many international experts read an innovative hub the territory of innovations [5] where thanks to tight correlations of the elements involved in it implementation of a full innovative stroke is provided. Advantages of tight integration of science, education, production potential are described in a large number of scientific works. But similar processes are tracked not in all regions of the Russian Federation. Among those it is possible to select also the Far Eastern Federal District (further – the FEFD).

The initiative command of Far Eastern Federal University [5] (further – FEFU) developed the concept of an innovative hub [6] capable to coordinate the main research and development, scientific and educational and innovative infrastructure of the FEFD, for an acceleration of its innovative and technological development. First of all federal higher education institutions of the region – DVFU and the Northeast Federal University (further – NFU) shall become a part of an innovative hub.

The above described initiative will allow to create the following advantages of the region:

1) to integrate the capacity of the scientific organizations, universities, science and technology parks, business incubators, technological enterprises and others;

2) to create a uniform information and communication field around all elements of a hub;

3) to strengthen innovative climate of the region;

4) to coordinate and systematize operation on development of innovations in the FEFD.

In the course of creation of an innovative hub the main problem is insufficient financing of its activities [5]. At the same time the purpose of investors, first of all represented by the state, maximum efficiency of functioning of an innovative hub is at the minimum volume of the spent money.

The analysis of efficiency of innovative hubs showed that there is some dependence between quantity of the money spent for formation of an innovative hub and its efficiency.

Because some participants of a similar hub often have the duplicating functions, there is relevant a question of assessment of the most rational way of financial security of its activities.

Use for the decision of this task of the formal statistical model based on probable interpretation of the quantitative assessment of a level of efficiency of innovative hubs is nonrational.

Due to the insufficient volume of statistical selection and the economic situation changing eventually.

For this reason, the decision to develop indistinct model [6] for assessment of efficiency of an innovative hub was made.

II. THE MODEL FOR ASSESSMENT OF EFFICIENCY OF AN INNOVATIVE HUB

Development of indistinct model was executed with use of the MatLab system, in particular a special packet of Fuzzy Logic Toolbox [7], in an interactive mode by means of graphic editing tools and visualization of all components of systems of an indistinct output. At the same time in indistinct model it is supposed to use 2 input variables and 1 output variable.

As the first input variable the amount of money selected for performance of work of FEFU within an innovative hub is used. Obviously, the more money it is allocated, the index of higher education institution by the number of the small innovative enterprises, intellectual property items, research and development and others will be higher.

As the second input variable the amount of money selected for performance of work of NFU within an innovative hub is used. This choice is caused by the same factors, as in a case from the first input variable [8].

As an output variable the efficiency of an innovative hub is used that is a basis for making decision by investors on the volume of the subsequent financing.

At the same time it is obvious, the more efficiency of elements of an innovative hub, the efficiency of a hub in general is higher [9].

III. The Algorithm of the Model

The analysis of such elements of an innovative hub as FEFU and NFU showed that it is possible to apply the following heuristic rules to assessment of efficiency of an innovative hub:

1) If FEFU is selected small amount of money and NFU is selected small amount of money, then the innovative hub is not effective.

2) If FEFU is selected small amount of money and NFU is selected the average amount of money, then an innovative hub low effective.

3) If FEFU is selected small amount of money and NFU is selected the large volume of money, then an innovative hub moderately effective.

4) If FEFU is selected average amount of money and NFU is selected the small amount of money, then an innovative hub moderately effective. (and to write: and so on 5 more rules as the first four)

5) If FEFU is selected average amount of money and NFU is selected the average amount of money, then an innovative hub moderately effective.

6) If FEFU is selected average amount of money and NFU is selected the large volume of money, then an innovative hub so-so effective.

7) If FEFU is selected the large volume of money and NFU is selected the small amount of money, then an innovative hub moderately effective.

8) If FEFU is selected the large volume of money and NFU is selected the average amount of money, then an innovative hub so-so effective.

9) If FEFU is selected the large volume of money and NFU is selected the large volume of money, then an innovative hub highly effective.

The following stage of creation of model is creation of the rule base. For this purpose, we will transform the provided higher than 9 heuristic rules to 9 rules of indistinct production:

RULE_1: IF “b1 is A little” and “b2 there is A little” THAT “b3 is Not effective”

RULE_2: IF “b1 is A little” and “b2 there is So-so” THAT “b3 is Low effective”

RULE_3: IF “b1 is A little” and “b2 there is Much” THAT “b3 is Moderately effective”

RULE_4: IF “b1 is So-so” and “b2 there is A little” THAT “b3 is Moderately effective” (and to write: and so on 5 more rules as the first four)

RULE_5: IF “b1 is So-so” and “b2 there is So-so” THAT “b3 is Moderately effective”

RULE_6: IF “b1 is So-so” and “b2 there is Much” THAT “b3 is So-so effective”

RULE_7: IF “b1 is Much” and “b2 there is A little” THAT “b3 is Moderately effective”

RULE_8: IF “b1 is Much” and “b2 there is So-so” THAT “b3 is So-so effective”

RULE_9: IF “b1 is Much” and “b2 there is Much” THAT “b3 is Highly effective”

For the reduced record of rules the following designations are used: b1 – the first input linguistic variable “Money for Performance of Work of FEFU”, b2 – the second input linguistic variable “Money for Performance of Work of NFU”, b3 – the output linguistic variable “Efficiency of an Innovative Hub”.

In quality the term set of the first linguistic variable is used a set of T1 = { “A little”, “So-so”, “Much” }. In quality the term set of the second linguistic variable is used a set of T2 = { “A little”, “So-so”, “Much” }. In quality a term set the day off of a linguistic variable is used a set of T3 = { “Not effective”, “Low effective”, “Moderately effective”, “So-so effective”, “Highly effective” } [10]. At the same time functions of accessory of terms from T1 are figured in a figure 1, functions of accessory of terms from T2 are figured in a figure 2, and functions of accessory of terms from T3 are figured in a figure 3.

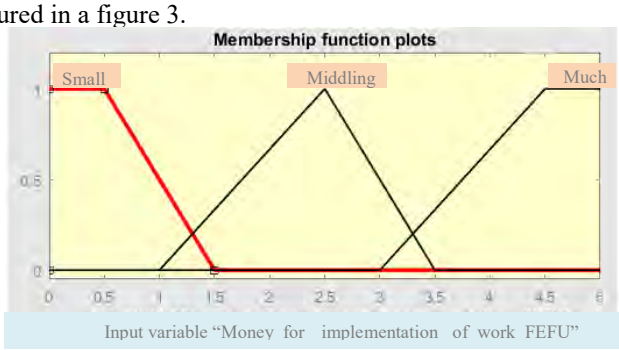

Fig. 1. Function graphs of accessory to terms of the input linguistic variable "Money for Performance of Work of FEFU”

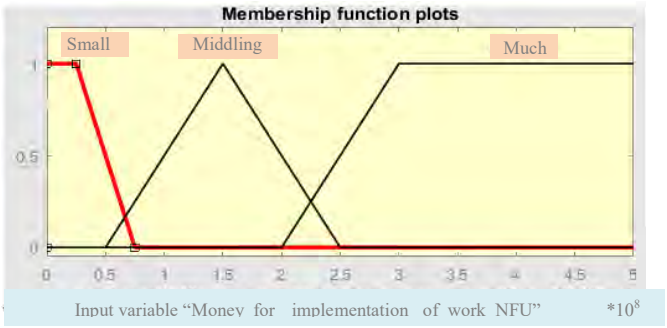

Fig. 2. Function graphs of accessory to terms of the input linguistic variable "Money for Performance of Work of NFU"

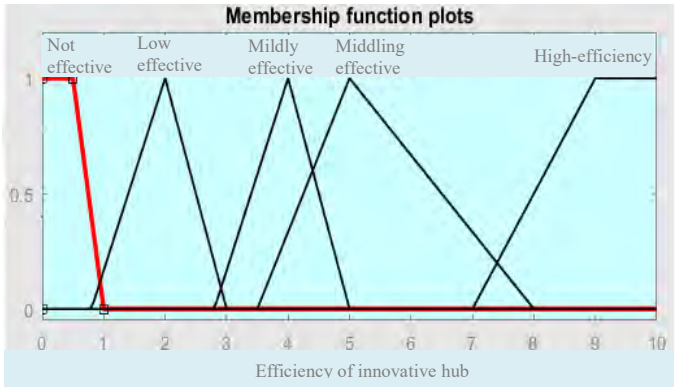

Fig. 3. Function graphs of accessory to terms of the output linguistic variable "Efficiency of an Innovative Hub"

Units of measure of money for performance of work both for the first, and for the second variable – rubles. The financial range is set from 0 – 5×108 rubles. Efficiency units of an innovative hub – points, where 0 smallest and worst point, and 10 the highest and characterizing the greatest efficiency of an innovative hub [11].

Systems analysis of problem area allowed to select expected quantity and a type of results of activities of elements of an innovative hub and to correlate them to the number of points [12].

So corresponds to 1 point – 14 small innovative enterprises (SIE), 14 000 000 rubles of annual income from individual share in MIP, 56 patents / the useful models / industrial samples, 42 publications in the scientific publications WoS and Scopus.

Further methods of aggregation of preconditions were defined. As in all rules 1-9 as a logical connective only indistinct conjunction (operation "I") is applied to subconditions, as a method of aggregation the operation min – conjunctions is used. As the diagram of an indistinct output the Mamdani method therefore MIN which is calculated by a equation (1) appears method of activation is used.

$$\mu'(y) = \min \{ci, \mu(y)\} \quad (1)$$

where μ (y) – function of accessory of a term which is value of some output variable shchj, Y set on a universum, ci – values of levels of truth of the subinferences for each of the rules entering the rule base of system of an indistinct output.

For accumulation of the inferences of rules the max method – disjunctions that is also applied in case of the diagram of an indistinct output by the Mamdani method is used. At last, as a method of a defazzifikation the method of the center of gravity for one-element sets, with use of a equation (2) was used.

$$y = \frac{\sum_{i=1}^{n} x_{i} \mu(x_i)}{\sum_{i=1}^{n} \mu(x_i)} \quad (2)$$

where n – number of single-point (one-element) indistinct sets, each of which characterizes a unique value of the considered output linguistic variable, μ () – function of accessory of a term.

For implementation of assessment of the constructed system of an indistinct output for the task of assessment of efficiency of an innovative hub the following was realized. In the browser of rules the MatLab systems are introduced values of input variables for a special case when for performance of work to Far Eastern Federal University 378 million rubles, and to the Northeast federal university of 256 million rubles were selected [13]. The procedure of an indistinct output performed by the MatLab system for the developed indistinct model shows as a result value of the output variable "Efficiency of an Innovative Hub", equal 8,77. Process of assessment is visually provided in a figure 4.

For more convenient perception of the name input and output variables were reduced [14]. In case of efficiency of an innovative hub (in this case, consisting of 2 elements) 8,77, with the total investment of 634 million rubles expected amount of results of its activities will be: 122 MIP; 491 patents / the useful model / industrial sample; 122 million rubles annual income from individual share in MIP; 368 publications in the scientific publications WoS and Scopus.

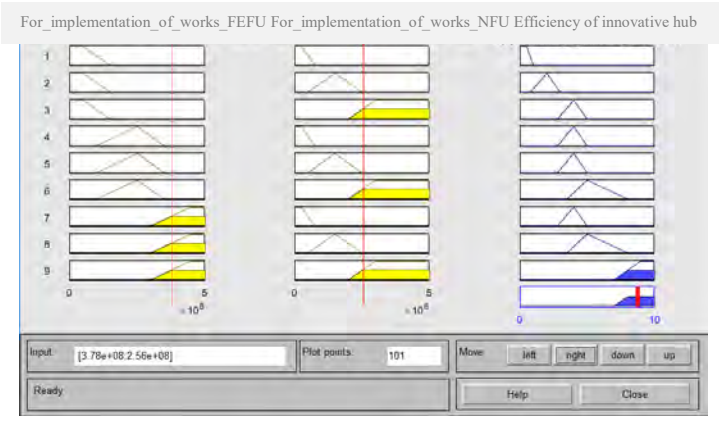

Fig. 2. The graphic interface of the browser governed after execution of the procedure of an indistinct output for values of input variables [3,78e +08; 2,56e +08]

For the general analysis of the developed indistinct model visualization of the appropriate surface of an indistinct output provided in a figure 5 can appear the useful.

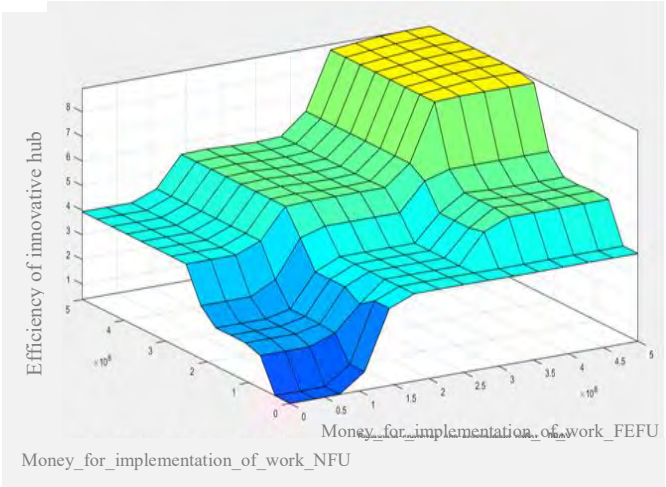

Fig. 5. Visualization of a surface of an indistinct output for the system of an indistinct output Hub

This surface of an indistinct output allows to set dependence of values of an output variable on values of input variables of indistinct model. For the purpose of determination of more adequate and suitable method for mathematical simulation we will construct the adaptive network-based fuzzy inference system (ANFIS) based on an algorithm Sugeno [15]. Stages of creation of neural network model are the type selection and structures of a neural network; training of a neural network; use of the trained neural network [16]. Creation of ANFIS will be carried out in an interactive mode by means of the special graphics editor of the adaptive networks in the Matlab system therefore at first we will create data the containing 25 lines of couples “value of the first input

variable value of the second input variable value of an output variable" [17]. Then we will generate structure of system of an indistinct output of FIS with which it is possible to get acquainted in a figure 6.

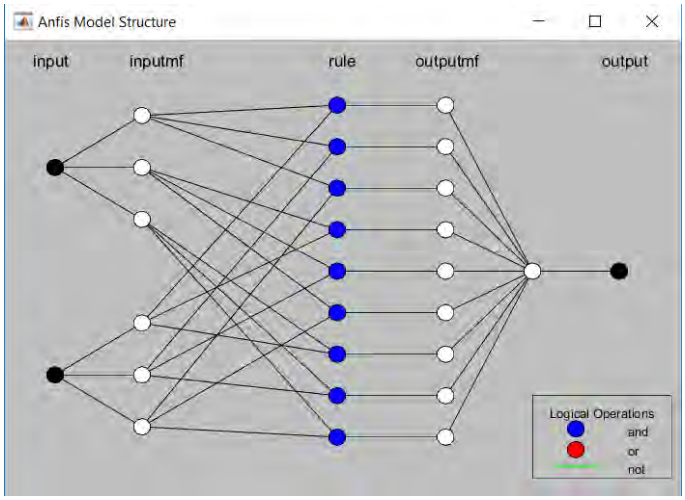

Fig. 6. The generated system of an indistinct output

Also before training in the editor it is necessary to set parameters: a training method – hybrid; training error level – 0; quantity of cycles of training – 40. Having performed the above-stated operations, it is obviously possible to visualize the constructed indistinct model shown in a figure 7 for the analysis.

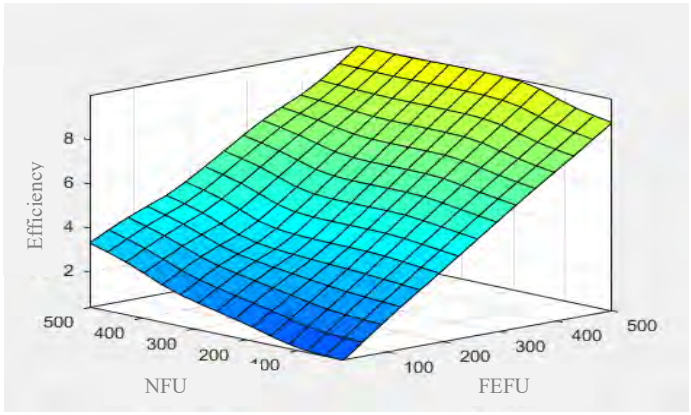

Fig. 7. Surface of the generated system of an indistinct output

As well as in case of creation of model with use of an algorithm Mamdani of a unit of measure of money – rubles. The financial range is set from 0 – 500 million rubles. Efficiency units of an innovative hub – points, where 0 smallest and worst point, and 10 the highest and characterizing the greatest efficiency of an innovative hub [18].

It is possible to analyze adequacy to the constructed model by means of viewing of rules of system, a figure 8.

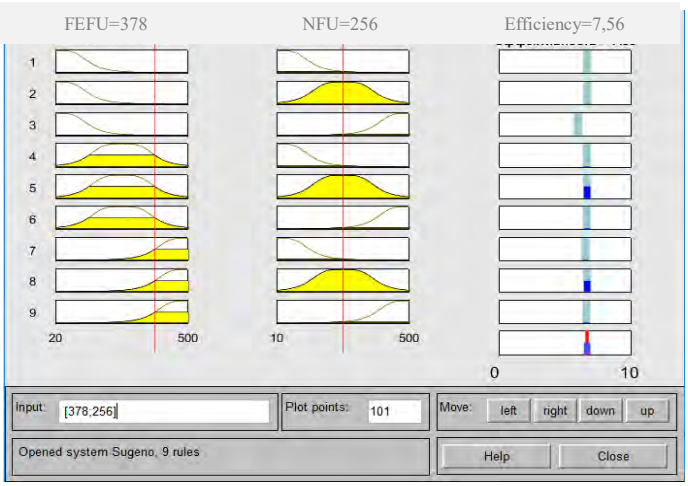

Fig. 8. The graphic interface of the browser governed after execution of the procedure of an indistinct output for values of input variables [378; 256]

Further in the program values of input variables for FEFU of 378 million rubles were entered, for NFU of 256 million rubles therefore the system shows value of the output variable "Efficiency of an Innovative Hub", equal 7,56 points that differs from value of the system based on an algorithm Mamdani, equal 8,77 in case of similar given parameters [19].

There is obvious a fact of inadequacy of one of the constructed indistinct models. In this case, absence of a large number of data for carrying out broader training of the adaptive network-based fuzzy inference system (ANFIS) based on an algorithm Sugeno demonstrates its smaller reliability and adequacy [20-22].

IV. Conclusion

The constructed adaptive network-based fuzzy inference system on an algorithm Mamdani shall form the basis of the full-fledged mathematical tool of assessment of efficiency of an innovative hub in the FEFD. For this purpose it is necessary to enter remaining elements of the hub assumed to start into model that will allow to develop a flexible and most productive policy of its quotient and/or public financing, relying on the result of innovative activities expected by customers.

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