ΛΌΓΟΣ

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COLLECTION OF SCIENTIFIC PAPERS

WITH PROCEEDINGS OF THE INTERNATIONAL SCIENTIFIC AND PRACTICAL CONFERENCE

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CONTENT

SECTION II.
ENGINEERING AND IT

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METHOD FOR DETERMINING MEMBERSHIP FUNCTION BASED ON EQUIDISTANT POINTS

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Introduction. The use of fuzzy logic is always relevant in determining membership functions (MF). This task is usually performed by experts or based on researcher's subjective judgment [1-2]. This paper proposes a new method for constructing MF which allows us to determine the function change intervals based on mathematical calculations.

Most notably, the use of the proposed method is possible only if you use fuzzy logic for decision-making systems to assess various objects or foresight. This paper will consider the technological foresight to defining critical technologies.

The issue of MF construction is quite common and discussed among experts [3-5]. However, the authors failed to find scientific papers on determining the MF using equidistant points. In addition, we know nothing about the use of fuzzy logic in the technological foresight.

The proposed method comprises three steps.

1. Approximating the distribution of technologies according to their criteria-based criticality estimates.

Having carried out preliminary research to determine the technology criticality, we get estimates for each criterion. That is, each technology obtains corresponding criticality estimate for each criterion. After receiving such data, it is possible to perform an approximation, i.e. to find an approximate function that shows the growth of the estimate by certain criterion for all technologies. By placing the technologies on the x-axis in criticality ascending order, we can obtain an approximate function that monotonically increases.

In the course of repeated calculations, the authors concluded that the most reliable approximate function is a third or higher degree polynomial.

2. Differentiating the approximate function and defining equidistant points.

In the vicinity of the point where the derivative is equal to one, the increment of the function and the increment of the argument are equal. The name of such a point is not a common concept, so the authors propose to call it "equidistant point" [6].

If the approximate function is a third degree polynomial we have two equidistant points (Fig.1).

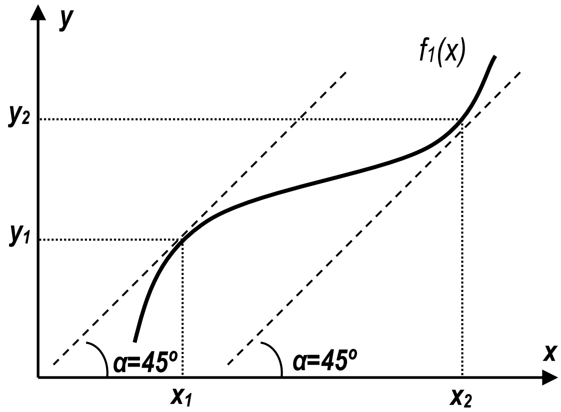

Fig.1. **Approximate function *f(x)*** *$f_1(x)$*

Figure 1 shows that there are two intervals where the function is changing. For *f(x)* on the intervals $x<x_1$ and $x>x_2$ the increment of the function increases much more than the increment of the argument, in contrast to $x_1<x<x_2$ where on the contrary the increment of the function increases insignificantly in comparison with the argument.

The approximate function can also be of a different type when on the intervals $x<x_1$ and $x>x_2$ the increment of the function increases much less than the increment of the argument and on the interval $x_1<x<x_2$ the increment of the function increases much more than the increase of the argument.

If we recall that the *x-axis* is a list of technologies in criticality ascending order, it is logical to conclude that technologies before point x_1 will have the lowest criticality, while technologies after point x_2 - the highest. We propose to consider the interval between these points as a fuzzy interval. It does not matter whether the approximate function is of the first or second type because in the same function the nature of its change will be different in these intervals.

3. Construction of MFs.

The theory of fuzzy sets does not require choosing the type of MF absolutely precisely. In this paper we will use a piecewise linear MF [7].

Having obtained equidistant points, we construct the MF of input linguistic variables (LV). In this case, the point (y_1) of the minimum value of the term N is the point of the maximum value of the term P and vice versa for the point y_2.

The *y-axis* of the approximate function *f(x)* is the argument for MF $\mu(y)$.

We propose to consider an example of application of the developed method.

Suppose that 12 technologies were estimated during a technological foresight. We construct a growth graph for the criteria estimates and perform an approximation to the third degree polynomial function (Fig. 2).

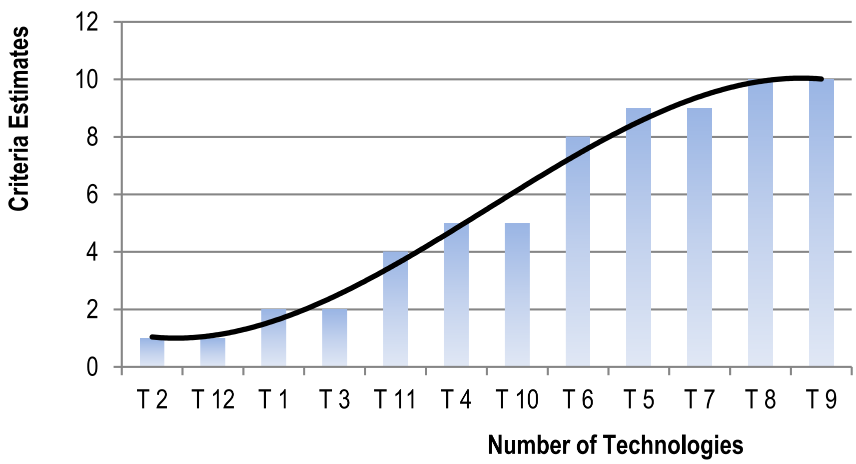

Fig.2. **Growth graph of criteria estimates**

We obtained an approximate function with 98% reliability:

$$y = -0,016x^3+0,324x^2-0,803x+1,535$$

The next step is to differentiate:

$$y' = -0,048x^2 + 0,648x - 0,803 = 1.$$

We found equidistant points:

$x_1 = 3.92; x_2 = 9.58.$

Next, we determined the criticality values ($y_1=2.4; y_2=9.5$) for determine the crisp boundaries of the MF (Fig. 3).

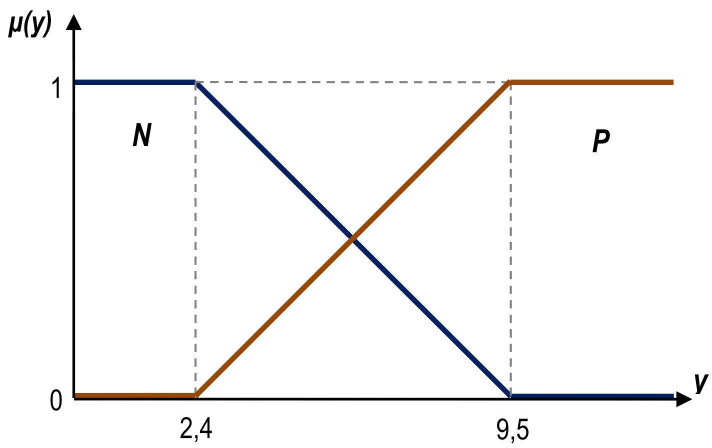

Fig.3. **Membership function**

Conclusions. The proposed method for constructing MF allows us to determine the intervals of function change free from experts' subjective judgment. Determining the MF is based exclusively on mathematical calculations using so-called equidistant points.

From the technological foresight perspective, this enables us to find a criticality level which is mathematically grounded and minimum satisfactory.

The analysis showed that the application of the proposed method of constructing MF and fuzzy logic in general is much better than the decision of the expert commission based on generalized estimates.

All of this, in turn, allows us to prevent miscalculations in technological forecasts and identify the most promising technologies.

The main area of further research may be to determine the intervals of MF change for more than two terms.

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