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Mathematical Model of a Rating Estimation of Competitiveness of Production on an Example of the Mountain Enterprise

Model of a rating estimation of competitiveness of production, realised by means of a method of definition of degrees of an accessory. As the factors influencing acceptance by the expert of the decision on assignment of a rating estimation of production, the same criteria, as in other models are considered: quality of production which it is possible to estimate an indicator «the importance of the technical decision», a financial priority from output, criteria of a production efficiency, and production sale. Necessity of creation of the given model is caused by that she allows to compare simultaneously some alternatives with the assistance of a commission of experts that gives the chance to solve problems of decision-making of various classes, both individual, and a group choice in conditions многокритериальности and uncertainty.

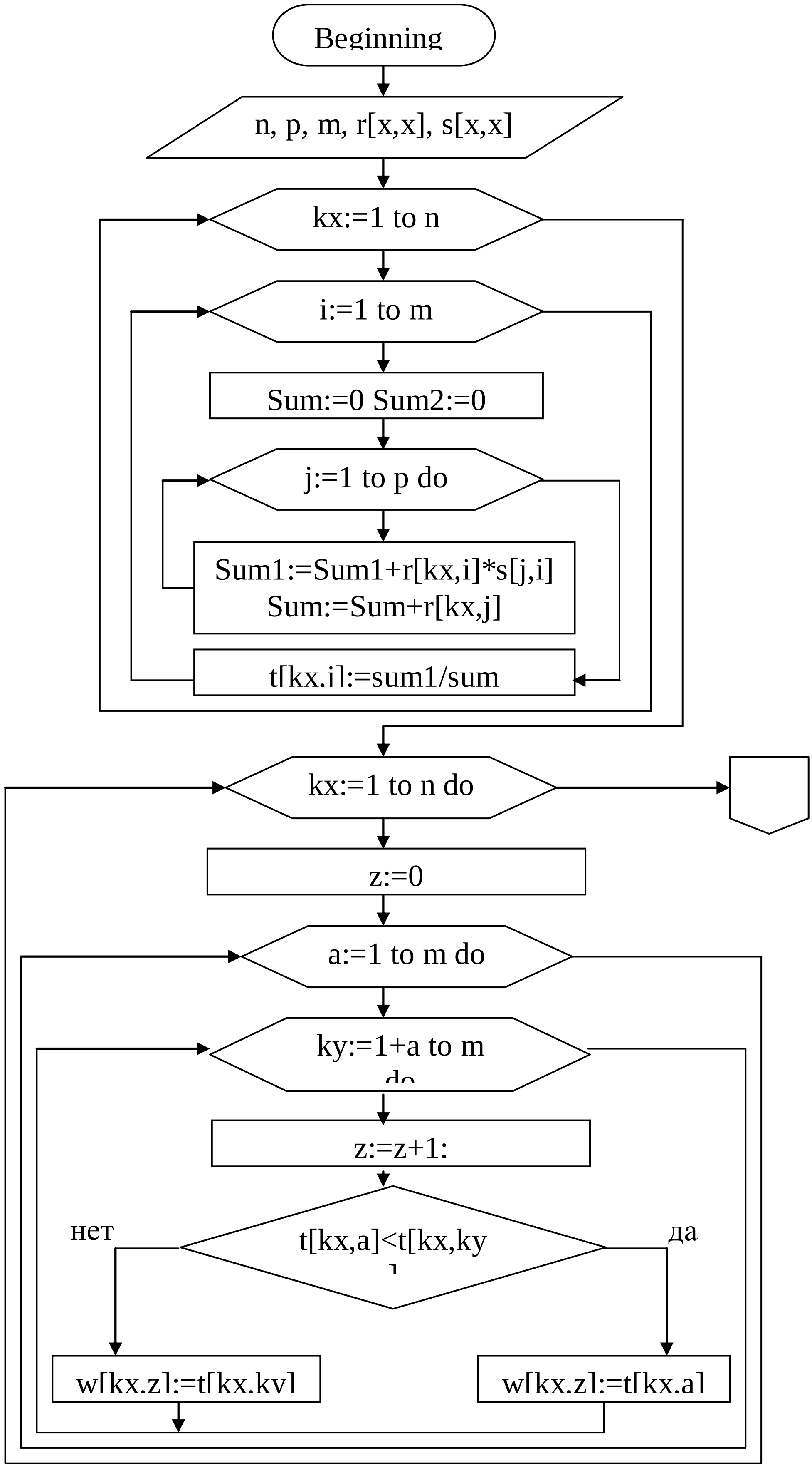
On the basis of the given method the software product "Rating" [56] is created.

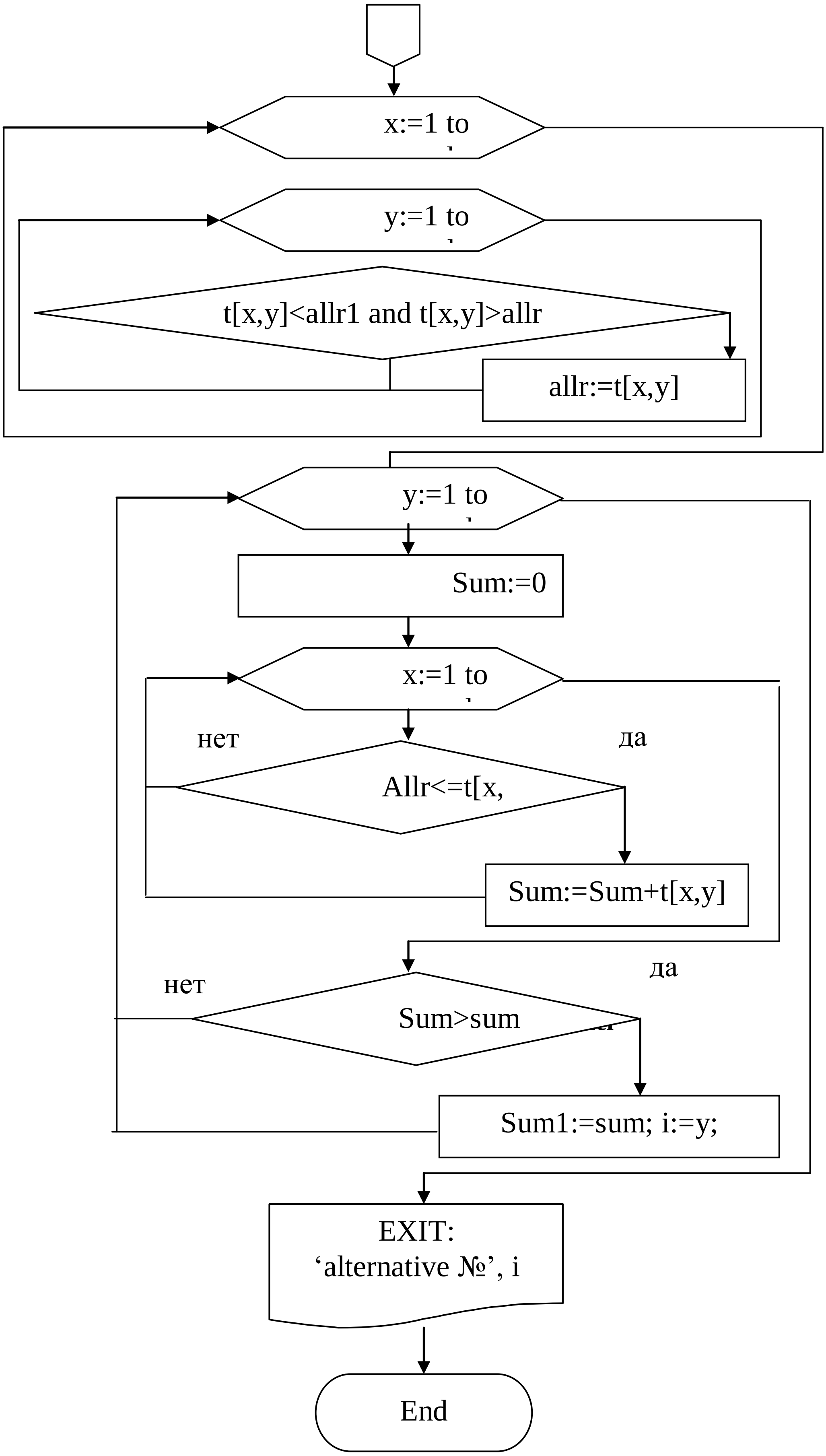
Program functional purpose: input of estimations of criteria; input of estimations of compatibility of alternatives with criteria; reception of a matrix of preferences of alternatives; calculation of a threshold of preference; calculation and a conclusion of rating estimations of alternatives.

Requirements to the computer and the software. **COMPUTER type - IBM PC AT Pentium 100; Language - Delphi 3; OC - Windows 95; program Volume - 366 Kb.**

Scope. The program "Rating" is a component of the software of system of support of decision-making on competitiveness of high technology production and is intended for definition of rating estimations of alternatives. As alternatives the enterprises, investment projects can act production.

The program Block diagramme is represented on fig. 3.1.


Beginning
n, p, m, r[x,x], s[x,x]
kx:=1 to n
i:=1 to m
Sum:=0 Sum2:=0
j:=1 to p do
Sum1:=Sum1+r[kx,i]*s[j,i]
Sum:=Sum+r[kx,j]
t[kx,i]:=sum1/sum
kx:=1 to n do
z:=0
a:=1 to m do
ky:=1+a to m
z:=z+1:
нет
t[kx,a]<t[kx,ky
да
w[kx,z]:=t[kx,ky]
w[kx,z]:=t[kx,a]


x:=1 to
y:=1 to
t[x,y]<allr1 and t[x,y]>allr
allr:=t[x,y]
y:=1 to
Sum:=0
x:=1 to
нет
да
Allr<=t[x,
Sum:=Sum+t[x,y]
нет
да
Sum>sum
Sum1:=sum; i:=y;
EXIT:
'alternative №', i
End

In model following assumptions are accepted: existence of certain level of competence of experts; production characteristic p signs; a variation of degree of importance of signs at assignment of given production of a rating between experts; preference of one kind of production to another if its signs on the degree of importance are closer to an estimation of experts.

It is supposed that $X=\{x_1, x_2, ..., x_n\}$ – set of experts, $Y=\{y_1, y_2, ..., y_p\}$ – set of signs of production and $Z=\{z_1, z_2, ..., z_m\}$ – set of kinds of production (alternatives). $\Phi_R : X \times Y \to [0,1]$ there is a function of an accessory of indistinct binary relation R. For all $x \in X$ and all $y \in Y$ function $\Phi_R(x,y)$ – degree of importance of a sign y according to the expert x at definition of preference of production by it. It is possible to present relation R in the matrix form [57,114]:

$$R = \begin{array}{c} \\ x_1 \\ x_2 \\ \dots \\ x_n \end{array} \begin{array}{c} \begin{array}{cccc} y_1 & y_2 & \dots & y_p \end{array} \\ \begin{bmatrix} \Phi_R(x_1,y_1) & \Phi_R(x_1,y_2) & \dots & \Phi_R(x_1,y_p) \\ \Phi_R(x_2,y_1) & \Phi_R(x_2,y_2) & \dots & \Phi_R(x_2,y_p) \\ \dots & \dots & \dots & \dots \\ \Phi_R(x_n,y_1) & \Phi_R(x_n,y_2) & \dots & \Phi_R(x_n,y_p) \end{bmatrix} \end{array}.$$

Then π: $Y \times Z \to [0,1]$ there is a function of an accessory of indistinct binary relation S. For all $y \in Y$ and all $z \in Z$ $\pi_s(y, z)$ - degree of an accessory or compatibility of production z with a sign y. In the matrix form the relation looks like [58,126]:

$$S = \begin{array}{c} \\ y_1 \\ y_2 \\ \dots \\ y_p \end{array} \begin{array}{c} \begin{array}{cccc} z_1 & z_2 & \dots & z_m \end{array} \\ \begin{bmatrix} \pi_S(y_1,z_1) & \pi_S(y_1,z_2) & \dots & \pi_S(y_1,z_m) \\ \pi_S(y_2,z_1) & \pi_S(y_2,z_2) & \dots & \pi_S(y_2,z_m) \\ \dots & \dots & \dots & \dots \\ \pi_S(y_p,z_1) & \pi_S(y_p,z_2) & \dots & \pi_S(y_p,z_m) \end{bmatrix} \end{array}.$$

Now it is possible to receive a matrix:

$$T = \begin{array}{c} \\ x_1 \\ x_2 \\ \dots \\ x_n \end{array} \begin{array}{c} \begin{array}{cccc} z_1 & z_2 & \dots & z_m \end{array} \\ \begin{bmatrix} \mu_{A1}(x_1,z_1) & \mu_{A2}(x_1,z_2) & \dots & \mu_{Am}(x_1,z_m) \\ \mu_{A1}(x_2,z_1) & \mu_{A2}(x_2,z_2) & \dots & \mu_{Am}(x_2,z_m) \\ \dots & \dots & \dots & \dots \\ \mu_{A1}(x_n,z_1) & \mu_{A2}(x_n,z_2) & \dots & \mu_{Am}(x_n,z_m) \end{bmatrix} \end{array},$$

elements with which are defined by accessory function

$$\mu_{Ai}(x, z_i) = \frac{\sum_y \Phi_R(x,y) \cdot \pi_S(y, z_i)}{\sum_y \Phi_R(x,y)} \quad \text{for all } x \in X,\ y \in Y, z \in Z, \qquad (3.5)$$

где $\sum_y \Phi_R(x,y)$

it is equal to the degree of an indistinct subset specifying number of the major signs *y* which the expert *x* uses for an alternative estimation, and $\mu_{Ai}(x, z_i)$ it is possible to interpret as preference of production z_i the expert *x* [58,126]. The function of preference described by the equation, satisfies to definition of a convex indistinct subset

$$\mu_{Ai}\left[\lambda(x_1, z_i) + (1-\lambda)\cdot(x_2, z_i)\right] \geq \min\left[\mu_{Ai}(x_1, z_i), \mu_{Ai}(x_2, z_i)\right],$$

for all x_1 and x_2 , all $z_i \in Z$ and all $\lambda \in [0,1]$. (3.6)

As all functions $\mu_{Ai}(x, z_i)$ convex, their crossings also convex functions. Thus, it is possible to construct a matrix:

$$W=\begin{bmatrix} \mu_{A1}(x_1,z_1)\wedge\mu_{A2}(x_1,z_2) & \dots\dots & \mu_{Am-1}(x_1,z_{m-1})\wedge\mu_{Am}(x_1,z_m) \\ \mu_{A1}(x_2,z_1)\wedge\mu_{A2}(x_2,z_2) & \dots\dots & \mu_{Am-1}(x_2,z_{m-1})\wedge\mu_{Am}(x_2,z_m) \\ \dots\dots & \dots\dots & \dots\dots \\ \mu_{A1}(x_n,z_1)\wedge\mu_{A2}(x_n,z_2) & \dots\dots & \mu_{Am-1}(x_n,z_{m-1})\wedge\mu_{Am}(x_n,z_m) \end{bmatrix}$$

The threshold of preferable competitiveness of alternative can be expressed a condition [58,126]:

$$w < \min_{ij}\max_{x}\min\left[\mu_{Ai}(x, z_i), \mu_{Aj}(x, z_j)\right].$$

If the threshold w is chosen, set of expert estimations Pi i=1..., m, received by the enterprise, it is described уровневым by set [58,126]:

$$P_i=\{x|\ \mu_{Ai}(x) \geq \min_{ij}\max_{x}\min\left[\mu_{Ai}(x,z_i), \mu_{Aj}(x,z_j)\right]\}\text{для всех } x\in P_i.$$

This model, as a matter of fact, is universal. Model application to examination of the enterprises or investment projects will be defensible. In any case, the sphere of application of the given model is wide enough, as confirms its utility. It is necessary to remember that accuracy of the rating estimations (results) received with use of given model, is defined by accuracy of definition of expert estimations in a matrix of binary relations and level of competence of experts.