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Method of Group Decision Making for Production Planning of the Oil Refinery Plant

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Abstract : This article is devoted to the problem of decision making under uncertainty. An aggregated approach is used that combines optimization and choice of a solution, which makes it possible to obtain a more realistic solution. The criteria in the vector optimization problem are: profit, product quality, employee satisfaction. To solve the optimization problem, 3 methods were used: "Goal programming", "Interactive", "FMOLP". The task of group decision making is implemented on the basis of the package FGDSS-CD (Fuzzy group Decision Support System).

Keywords: Uncertainty, group decision making, planning, oil refinery plant, fuzzy , goal programming, interactive, FMOLP

I. INTRODUCTION

The group decision making methods have been developed for solving semi structured and unstructured problems [1-6], so for problems with high level of uncertainty of information. Uncertainty can be related with imprecise of given data and with uncertainty of goals so when we have several contradictory objectives. These methods usually are used for problems where alternatives are presented in non numerical values. As rule the preferences of experts are expressed by linguistics terms. In systems are based on group decision making technology , the experts make decisions by evaluation of proposed alternatives. The evaluation process is based on the intuition, experience and special algorithm of achieving consensus.[7-9].

General structure of group decision making is presented on Fig. 1.

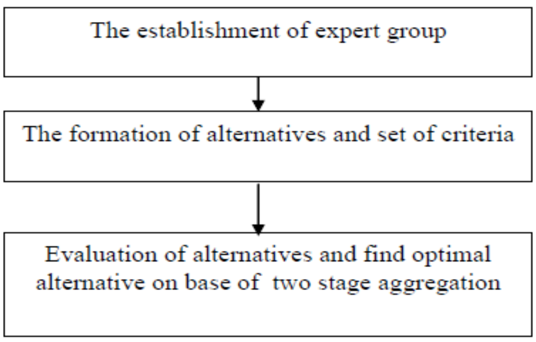

Fig. 1. General structure of group decision making

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If necessary, in general structure can be included the blocks for conversation pair wise values into absolute ones and normalization procedures. The most known methods are following:.

- ELECTRE method (Elimination and Choice Expressing Reality);[10-12]/
- AHP method (Analytic hierarchy process);
- TOPSIS method (Technique for order Preference by similarity to ideal solution) and others;

The ELECTRE method was first method of classification alternatives. It was proposed by French scientist B.Rua. AHP method was proposed by American scientist T.Saati for analysis situation where application of mathematical methods is impossible. TOPSIS method use the approach where decision based on compromise of maximum distance from negative ideal and minimum distance from positive ideal decisions.

Consider the general scheme of group decision making. The group of experts E_k (к=1,..L) are given. For any expert is assigned the weight coefficient $w_k(k=1,...,L)$. This coefficient is reflects the trust level of expert. The set of criteria for evaluation of alternatives are given F_j ($j=1,...,m$)

For any criteria the weight is assigned v_j ($j=1,...,m$)

Also the set of alternatives is determined

A_i, $i=1,...,n$

The process of determination of optimal alternative can be describe by two stage procedure . This process can be presented in pay off table form .

	v_1	v_2		v_m	
	F_1	F_2	....	F_m	
A_1	C_{11}	C_{12}		C_{1m}	$\overline{C}_1^{(k)}$
		C_{ij}			$\overline{C}_2^{(k)}$
...	...	...	...	...	
A_n	C_{n1}	C_{n2}	...	C_{nm}	$\overline{C}_n^{(k)}$

Here $\overline{C}_i^{(k)}$ -is aggregative value of i-th alternative by **k**-th expert, C_{ij} -value of i-th alternative by j-th criteria C_{ij} are determine by expert by estimation . For any expert E_k the payoff matrix is built. For any κ alternative aggregative values $\overline{C}_i^{(k)}$

$$\sum_{j=1}^{m} c_{ij} v_j = \overline{C}_l^{(k)} \qquad k = \overline{1,l}, \quad i = \overline{1,n}$$

In second stage the matrix of values by all experts is established. All operations are performed on base of fuzzy approach.

	w_1	w_2		w_l	
	E_1	E_2	E_k	E_l	C_1^*
A_1	$C_1^{(1)}$	$C_1^{(2)}$	$C_1^{(k)}$	$C_1^{(l)}$	C_2^*
A_2					
....	...	...	...	...	...
A_n	$C_n^{(1)}$	$C_n^{(2)}$	$C_n^{(k)}$	$C_n^{(l)}$	C_n^*

On base of weight coefficients of expert w_k $\quad k = \overline{1,\ell}$ the aggregative value for any alternative are determined.

$$\sum_{k=1}^{\ell} w_k C_k^* = C_i^*$$

The process is finished by determination of optimal

alternative so aggregative solution by all experts C_i^* .

$$i^* = \max_i C_i^*$$

All group decision making methods are based on this general scheme , Fuzzy versions of this approach differs on usage of linguistic variables.

Consider the planning of oil refinery plant. The problem is present in multicriteria variant. Refinery process consists of two units: production and compound. (Fig.2)

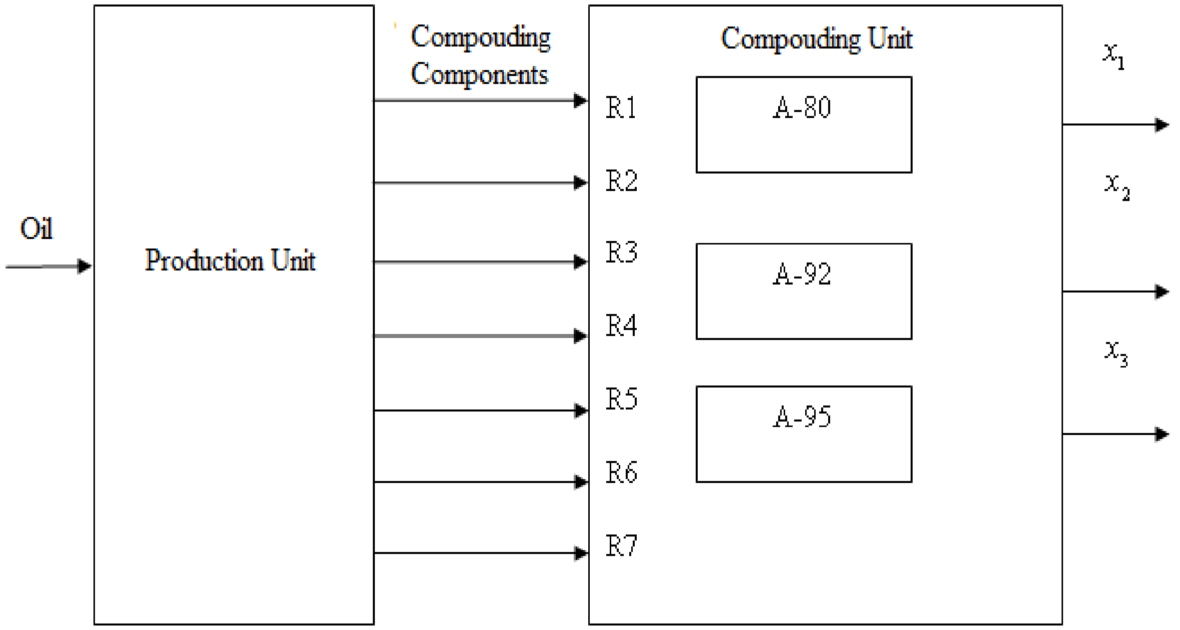

Fig. 2. The major units of oil refinery process

Production unit realize two stages oil refinery process. In the first stage is conducting of primary oil processing, in the next stage the catalytic cracking and coke processes are performing. In production unit are produced the fraction which are used needed for manufacturing car petrol.

II. METHOD

The fuzzy planning problem statement

In last years many scientists for planning problem use multicriteria problem where are used economical, social and ecology criteria. In this connects the fuzzy problem statement can be presented as following:

Fuzzy Goal function includes three functions : profit, product quality, worker satisfaction

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$$max\ \tilde{f}(x)=max\begin{pmatrix}\tilde{f}_1(x)\\ \tilde{f}_2(x)\\ \tilde{f}_3(x)\end{pmatrix}=max\begin{pmatrix}\tilde{c}_{11}x_1+\tilde{c}_{12}x_2+\tilde{c}_{13}x_3\\ \tilde{c}_{21}x_1+\tilde{c}_{22}x_2+\tilde{c}_{23}x_3\\ \tilde{c}_{31}x_1+\tilde{c}_{32}x_2+\tilde{c}_{33}x_3\end{pmatrix}=max\begin{pmatrix}\widetilde{288}x_1+\widetilde{290}x_2+\widetilde{300}x_3\\ \tilde{8}x_1+\tilde{5}x_2+\tilde{3}x_3\\ \tilde{4}x_1+\tilde{8}x_2+\tilde{6}x_3\end{pmatrix}$$

fuzzy constraints:

Resource constraints :

HK-85 fraction: $\tilde{a}_{11}x_1+\tilde{a}_{12}x_2+\tilde{a}_{13}x_3=\widetilde{0.2289}x_1+\widetilde{0.01028}x_2\leq b_1=27611.9$

Stabile platformate

$$\tilde{a}_{21}x_1+\tilde{a}_{22}x_2+\tilde{a}_{23}x_3=\widetilde{0.0691}x_1+\widetilde{0.3494}x_2+\widetilde{0.7857}x_3\leq b_2=\widetilde{386214}$$

Coker gasoline: $\tilde{a}_{31}x_1+\tilde{a}_{32}x_2+\tilde{a}_{33}x_3=\widetilde{0.0846591}x_1\leq\tilde{b}_3=\widetilde{6925.4}$

high-octane component:

$$\tilde{a}_{41}x_1+\tilde{a}_{42}x_2+\tilde{a}_{43}x_3=\widetilde{0.4901}x_1+\widetilde{0.6402}x_2+\widetilde{0.2142}x_3\leq\tilde{b}_4=\widetilde{614955}$$

Virgin gasoline: $\tilde{a}_{51}x_1+\tilde{a}_{52}x_2+\tilde{a}_{53}x_3=\widetilde{0.04718}x_1\leq\tilde{b}_5=\widetilde{3858}$

HK-85-180 fraction: $\tilde{a}_{61}x_1+\tilde{a}_{62}x_2+\tilde{a}_{63}x_3=\widetilde{0.01289}x_1\leq\tilde{b}_6=\widetilde{1054.40}$

Hydro treated gasoline: $\tilde{a}_{71}x_1+\tilde{a}_{72}x_2+\tilde{a}_{73}x_3=\widetilde{0.0671}x_1\leq\tilde{b}_7=\widetilde{5487.8}$

Plan constraints:

Production of gasoline A-80: $\tilde{a}_{81}x_1+\tilde{a}_{82}x_2+\tilde{a}_{83}x_3=\tilde{1}x_1\geq\tilde{b}_8=\widetilde{2000}$

Production of gasoline A-92: $\tilde{a}_{91}x_1+\tilde{a}_{92}x_2+\tilde{a}_{93}x_3=\tilde{1}x_2\geq\tilde{b}_9=\widetilde{2000}$

Production of gasoline A-95: $\tilde{a}_{101}x_1+\tilde{a}_{102}x_2+\tilde{a}_{103}x_3=\tilde{1}x_3\geq\tilde{b}_{10}=\widetilde{2000}$

Products quality constraints :

$$\tilde{a}_{111}x_1+\tilde{a}_{112}x_2+\tilde{a}_{113}x_3=\widetilde{0.277569}x_1\geq\tilde{b}_{11}=0$$

$$\tilde{a}_{121}x_1+\tilde{a}_{122}x_2+\tilde{a}_{123}x_3=\widetilde{0.07372}x_2\geq\tilde{b}_{12}=0$$

$$\tilde{a}_{131}x_1+\tilde{a}_{132}x_2+\tilde{a}_{133}x_3=\widetilde{0.0062}x_3\geq\tilde{b}_{13}=0$$

Balance constraints : $\tilde{a}_{141}x_1+\tilde{a}_{142}x_2+\tilde{a}_{143}x_3=\tilde{1}x_1+\tilde{1}x_2+1\tilde{x}_3\leq\tilde{b}_{14}=\widetilde{1046107.1}$

Where x_1-amount of gasoline A-80, x_2- amount of gasoline A-92, x_3- amount of gasoline A-96.Coefficiets of objective functions and constraints are presented by fuzzy triangle numbers (LR) type.

$$\mu_{\tilde{a}}(x)=\begin{cases}0, & x<a \text{ или } c<x\\ (x-a)/(b-a), & a\leq x<b\\ 1, & x=b\\ (c-x)/(c-b), & b<x\leq c\end{cases}$$

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III. RESULTS

This problem have been solved by three methods of multicriteria optimization : FMOLP, GOAL programming, Interactive method.

Consider the one scheme of group decision making to problem to find consensus of decision which have been achieved by three different methods. As results of solving oil refinery planning problem on base of multicriteria model with 3 criteria-profit, quality and worker satisfaction by three different methods, ("Goal programming ","Interactive", "FMOLP") are presented in Table 1.

Table 1.

"Goal programming" method	"Interactive" method	"FMOLP" method
X[1] = 42079,3098 X[2] = 897406,6352 X[3] = 88777.4486 $\tilde{f}_1(x) = 290\tilde{0}000000$ $\tilde{f}_2(x) = 509\tilde{0}000$ $\tilde{f}_3(x) = 788\tilde{0}235$	X[1] = 48013.8179 X[2] = 901917.0926 X[3] = 65434.6646 $\tilde{f}_1(x) = 29501\tilde{4}335.7861$ $\tilde{f}_2(x) = 509\tilde{0}000$ $\tilde{f}_3(x) = 780\tilde{0}0000$	X[1] = 42117.8841 X[2] = 898834.0329 X[3] = 88139.2835 $\tilde{f}_1(x) = 29923\tilde{3}3636.19$ $\tilde{f}_2(x) = 509\tilde{5}531.98$ $\tilde{f}_3(x) = 788\tilde{7}979.81$

These solutions are considered as alternatives A_1, A_2, A_3 and also group of experts E_1, E_2, E_3 are presented for find final decision of problem. For solving this problem is used software package FGDSS-CD(Fuzzy group Decision Support System). In first stage are determined weight coefficients of any expert and list of criteria (Fig. 3.)

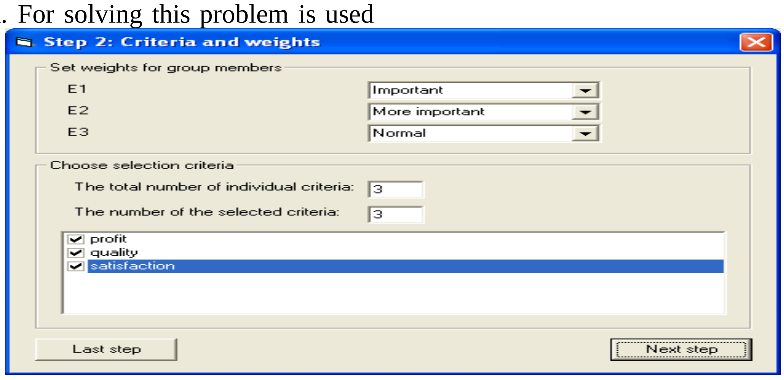

Fig.3. The determination weight coefficients of experts and forming of criteria set.

In next step any expert enter the pairwise matrix of own preferences to the criteria and evaluate all alternatives . All operations are realized in the fuzzy formalism (Fig. 4).

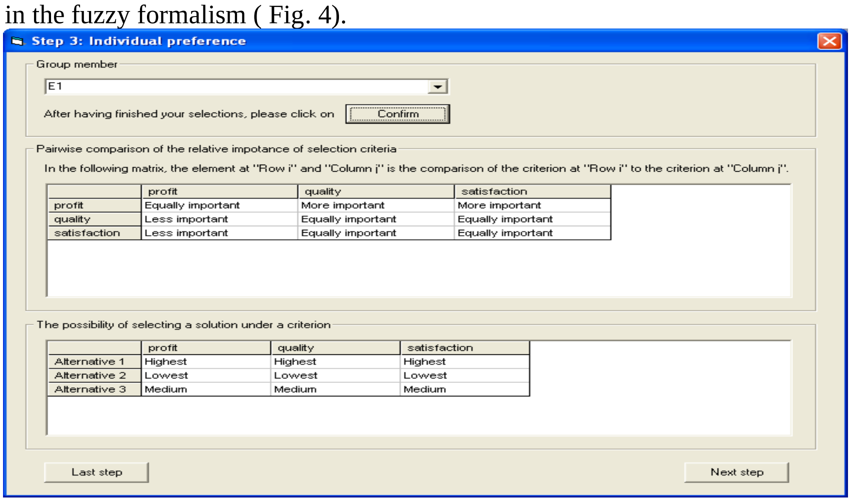

Fig. 4. Entering the pairwise preferences matrix and alternative's evaluation for expert E_1.

In next step was performed aggregation procedure by experts.(Fig.5.)

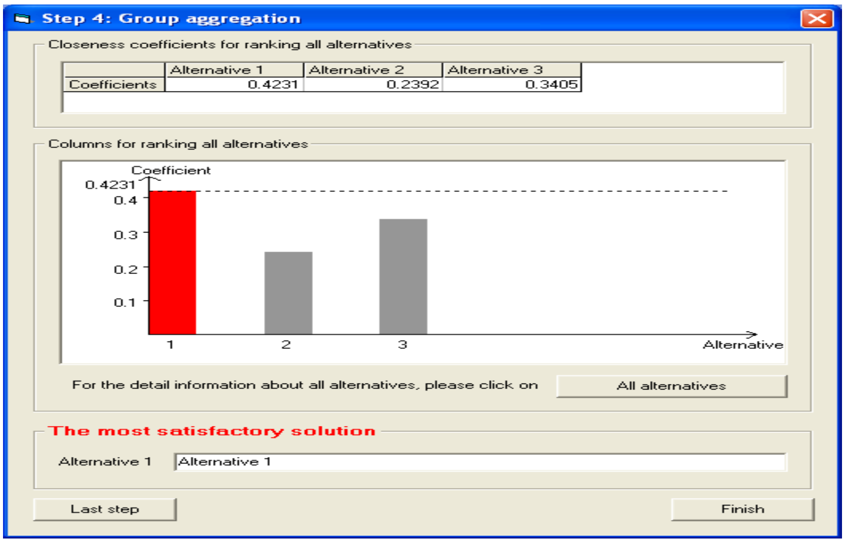

Fig. 5. The achievement of the final decision

As result of twice aggregation we have final decision (first alternative was selected).

IV. CONCLUSION

İn this paper the method of group decision-making is developed for a solving problem of planning of process of oil refinery under uncertainty. From three results obtained by three decision groups wich applied various approaches , the problem of choosing an optimal solution was solved.

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