

Operational Risk Analysis through Simulation

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Abstract: Decision-making process in any organization concerns its future development, which is clearly subject to uncertainty. The risk comes from the inability of people to know what will happen in time and it is perceived when uncertainty and possible effects of a decision making are significant. It is known the fact that most management problems are dependent on the economic effect of a decision which in turn depends on a number of random factors, which can take infinite values. It follows that there are a large number of combinations that affect the effect of the decision, the estimation of the probability distribution for the values associated effect being difficult. The problem can be solved in this case with the aid of simulation, because it can generate several times the most probable combinations, offering the possibility of establishing an optimal decision making. Optimizing the decision involves the identification of alternative ways of determining the decision-makers who must meet the requirements under consideration of multiple objective functions. Because a lot of possible decision alternatives are evaluated through the influence of several factors, such as internal or external, the inability to maintain the decision, as time passed, there were used several methods to optimize decision assisted by computer, such as: Electre, global utility method or algorithms derived from the global fuzzy set theory. Fuzzy set theory refers to testing the truth value of sentences that is represented in the system by a real number belonging to interval $[0, 1]$, where 0 corresponds to the state of False, and 1 corresponds to the state of Truth. In the opinion of a decision maker, fuzzy set theory implies the existence of a set of alternatives X decision, which will select the optimal decision, and the existence of a function $f(x)$ that takes values in the range $[0,1]$, depending on the degree the alternative decision x satisfies economic criteria considered.

Keywords: simulation, risk, decision, fuzzy set, optimization.

Introduction

At present, for any organisation, knowledge is the most important strategic resource, which should be managed in such a way as to achieve competitive advantage. The changes of the business environment generated by the phenomenon of globalization and intensification of competition highlight new forms of organisation which move the traditional boundaries of the organisation. Thus, it requires a reconsideration of the development of the information systems' functionality in conjunction with the use of new information and communication technologies (Internet, Intranet, data warehouses, Data Mining), which allow the capitalization and generation of new knowledge, and the application of the existing ones. To optimise the decision-making act, each organisation has created a knowledge base by means of which they are viewed both as process and object, thus developing the degree of comprehension and their use by decision-makers.

Regarded as object, knowledge, in order to be stored and handled properly, must be explicit, transmissible, using a formal language that refers to managerial situations or decision-making issues that can be solved on its basis. From a procedural perspective, knowledge is considered from the point of view of its management impact on the organisational effectiveness. Within the organization, in pursuit of management processes and relationships, the decision-making, operational and information elements interact on the basis of causal relations, offering the organisation's management system the property to reorganise spontaneously, on the basis of self-regulatory mechanism. Analysing the information criteria (accuracy, completeness, reliability, opportunity) we understand the way they condition the quality and accuracy of decisions, a basic aspect that makes the alternatives available to the decision-maker be determined by objective elements and by his/her own cognitive or information limitations.

The imperfect unstructured information associated to random uncertain phenomena that influence the business environment creates discomfort to the decision-maker, demonstrating once again its limitation of knowledge and evaluation of all materials necessary for selecting the optimal decision. In an uncertain environment, the manager takes satisfactory decisions, being conditioned by *limited rationality*. (Concept defined by Herbert Simon) [4, p. 66]

The limited rationality of the decision-maker is characterised by ambiguity and it occurs when, in the context of the decision-making process, we are provided incomplete, inconsistent, unpredictable information, leading to the emergence of the risk factors. The integration of information technology in assisting the decision-making processes is compulsory because, at a strategic and tactical level, there is used an impressive volume of data and information that requires automatic processing, without which, the identification of decision-making alternatives would not be possible, and errors in their justification would have long-term consequences on all components of the management system. Building an efficient information infrastructure adapted to the present or future requirements of the organization is no longer a basic condition but a finding, for those who practice a performance management oriented to the maximization of results, the creation of added value, the development of knowledge and know-how.

1. The Determination of the Best Computer – Aided Decision in Multicriteria Uncertainty Conditions

The optimization of economic activities by means of unicriteria methods represents the identification of way to determine the decision-making alternative, approved by all decision-makers, taking into account more functions objectively. Due to the fact that a large proportion of decision-making possible alternatives are evaluated through the prism of the influence of several internal or external factors that maintain the inability of founding decisions, over time there have been used a number of computer aided optimization methods, as: Electre, the global utility method or algorithms derived from fuzzy theory of multitudes. Regardless of the method chosen, due to the complexity of calculation algorithms and the emergency of the time of action, decision-makers prefer associating them with a series of dedicated software.

1.1. Applications of Fuzzy Techniques in the Decision Theory

The Fuzzy multitude theory refers to testing the validity of a sentence which is represented in the system by means of a real number from the interval $[0, 1]$, where 0 corresponds to the status of False, and the status of 1 corresponds to the status of truth. In terms of a decision-maker, fuzzy multitude theory supposes the existence of a decision-making alternative X, from which there will be selected the optimal decision, and the existence of a function $f(x)$ that takes values in the range $[0,1]$, depending on the degree to which the decision-making alternative x meets the economic criteria taken into account. [9, p. 137, 138]

Lotfi Zahed, in the work Fuzzy sets: information and control and Bellman consider that a decision is viewed as optimal if it meets both the objectives and set restrictions. Ronald Yagger granted through membership coefficients assigned to each objective or constraint, a different varied importance, which requires an exponential calculation for determining the membership of decision-making alternatives to the aggregate $[0, 1]$.

1.2. The Algorithm Derived from the Vague Aggregate Theory

Unlike the models developed by R. Yagger and H. G. Zimmerman, in the Japanese management, there have been used and developed a series of algorithms that assigns the decision-making criteria coefficients belonging to the best variant, in the interval $[2, 6]$. Thus, if the criterion J is more important than criterion K, at the moment of decision-making, then the membership coefficient associated to it will take values close to 6. Knowing the values of the affiliation coefficients and the matrix of relative consequences, the algorithms must undergo a sequence of stages, so that, in the end, by applying specific methods, to be able to reflect the degree of optimism or pessimism of the decision-maker.

Thus, *in the first stage*, the absolute consequences are expressed in relative values, fact that leads to the generation of a matrix, written $CR = (C_{rij})$, where $i = 1, \dots, n$ and $j = 1, \dots, m$, for which a certain element is obtained by applying the ratio (1.):

$$C_{rij} = \frac{C_{aij}}{\sum_{i=1}^n C_{aij}} \quad (1.)$$

where:

C_{rij} – relative consequence of the decisional alternative i according to the criterion j ;
 C_{aij} – absolute consequence of the alternative i according to the criterion j ;

$\sum_{i=1}^n C_{aij}$ - represents the sum of absolute consequences of those n alternatives for a certain criterion j .

The formal expression of the algorithm has to be preceded by the emphasis operation of the memory areas that will ensure its taking over by the computer.

- ✓ N , has natural value and is memory variable, fact that indicates the number of decisional alternatives;
- ✓ M , is memory variable with natural value, representing the number of economic criteria taken into account;
- ✓ $CA(N, M)$, the matrix of absolute consequences of those N alternatives analysed according to M criteria;
- ✓ $K(M)$ is the vector of affiliation coefficients of each criterion to the optimal variant;
- ✓ $CR(N, M)$, matrix of relative consequences;
- ✓ $S(M)$ represents the vector of the sum of absolute consequences of all alternatives for each criterion, values necessary for the calculation of the elements of matrix $CR(N, M)$.

The second stage begins with the calculation of the elements of the helping matrix $Z(N, M)$, for which the maximum or minimum criterion is chosen, fact that will contribute to the calculation of the most favourable relative consequence of the criterion j noted with c_j^* . The vector $CS(M)$ will retain the most favourable relative consequences for each of those M criteria. The calculation of the elements of matrix $Z=(z_{ij})$, with $i = 1, n$ and $j = 1, m$ is done using the ratio (2.):

$$z_{ij} = \frac{|C_{rij} - c_j^*|}{c_j^*} \quad (2.)$$

The favourable relative consequence takes the lowest value, if the criterion is minimum, and the highest for a maximum criterion.

In the third stage there are established the elements of the matrix of the characteristic functions, $FC = (f_{cij})$ with $i = 1, n$ and $j = 1, m$. the characteristic function associated to alternative i and the criterion j is rendered by the following formula: (3.):

$$f_{cij} = e^{-K_j z_{ij}} \quad (3.)$$

where, K_j represents the affiliation coefficient attributed to criterion j .

In the fourth stage, there is determined the optimal decisional alternative, for the association of the matrix of characteristic functions with the following specific methods, calculated in accordance with the formulas (4.), (5.), (6), (7):

- ✓ *The pessimist technique (Abraham Wald)*, says that the optimal variant is that ensuring maximum advantages when the objective conditions are most unfavourable.

$$V_{\text{optimală}} = \max_i \min_j FC_{ij} \quad (4.)$$

- ✓ **The optimist technique** considers as optimal alternative the situation when the objective conditions are most favourable.

$$V_{\text{optimală}} = \max_i \max_j FC_{ij} \quad (5.)$$

- ✓ **The proportionality technique (Bazes - Laplace)** says that each state of objective conditions has the same probability of appearance, and the optimal decisional alternative is that for which the arithmetic average of the characteristic functions is the most favourable.

$$V_{\text{optimală}} = \max \frac{1}{n} \times \sum_{j=1}^n FC_{ij} \quad (6.)$$

- ✓ **The optimality technique (Leonid Hurwicz)** is a variant of the pessimist and optimist techniques, based on the introduction of an optimism coefficient α ($0 < \alpha < 1$).

$$V_{\text{optimală}} = \max[\alpha * Ai + (1 - \alpha) * ai] \quad (7.)$$

where: ai is the least favourable element of alternative i , and Ai , the most favourable element of alternative i .

Depending on the method approved by the decision-maker, the optimal alternative can be determined by applying any variations as described above, or by using several methods, classifying decisional variants depending on the requirements, and finally to ensure comparability of results. To support the above arguments, I will present the way there can be used the algorithm derived from the theory of vague aggregates for solving a decisional problem caused by a series of strategic situations, whose action affects the economic activity of the organization during the period 2012-2016.

2. Case Study. Analysing the Volume of Future Production and of the Prices Practiced According to the Contracting Offers Using the Algorithm Derived from the Theory of Vague Aggregates

An organisation A, as producer and supplier of the aviation industry, receives towards the end of 2011, four offers of production contracting whose effects will run for a period of five years. Due to the fact that each of them looks attractive, the customers' requests are handed in to the management team, together with the current activity data, the management team having to set criteria used for selection, the level of importance given to each, and the methods and techniques used to identify the decisional alternatives and the optimal variant.

2.1. Historical Aspects of the Evolution of Organisation A, form an Economic and Operational Point of View

In the period 2007 - 2011, organisation A presented the following activity results, (Table no. 1 and no. 2):

Performances achieved by the company A in the period 2007-2011

Table no. 1

<i>Indicators – lei</i>	<i>2007</i>	<i>2008</i>	<i>2009</i>	<i>2010</i>	<i>2011</i>
Intangible assets	608,354	551,786	570,222	480,564	632,816
Tangible assets	35,718,935	33,302,730	36,155,508	45,386,521	74,452,683
Financial assets	2,826,048	493,881	467,089	349,291	374,095
<i>Fixed assets</i>	<i>39,153,337</i>	<i>34,348,397</i>	<i>37,192,819</i>	<i>46,216,376</i>	<i>75,459,594</i>
Stocks	16,062,650	18,386,801	16,603,505	12,535,857	15,474,466
Receivables	36,955,757	34,606,109	25,695,909	17,586,980	32,072,297
Financial investments	0	0	0	39,123,786	37,113,524
Cash	1,968,774	19,304,753	24,209,064	329,974	439,799

<i>Indicators – lei</i>	<i>2007</i>	<i>2008</i>	<i>2009</i>	<i>2010</i>	<i>2011</i>
<i>Current assets</i>	54,987,181	72,297,663	66,508,478	69,576,597	85,100,086
<i>TOTAL ASSETS</i>	94,140,518	106,646,060	103,701,297	115,792,973	160,559,680
<i>Equity ownership</i>	68,735,092	74,564,238	85,601,291	102,346,114	142,440,460
Registered capital	29,284,133	29,284,133	29,284,133	29,284,133	37,483,690
Share premium	0	0	0	0	0
Reserves	27,646,966	30,308,223	38,140,649	41,393,663	54,292,215
Non distributed result (profit)	0	0	0	0	0
<i>Profit (or loss) for the period</i>	10,146,868	9,503,724	10,209,987	11,276,413	11,618,296
Repartition of the profit	545,823	549,232	2,042,597	3,076,856	850,798
Subvention	145,412	106,483	67,555	2,106,627	3,673,360
Provisions	2,057,536	5,910,907	9,941,564	21,362,134	36,223,697
Public patrimony	0	0	0	0	0
Long and medium-term debts (> 1 year)	720,978	1,127,393	0	39,750	0
<i>Permanent capital</i>	69,468,570	75,705,231	85,604,988	102,386,200	142,440,460
Short-term debts	24,671,948	30,940,829	18,096,309	13,406,773	18,119,220
<i>TOTAL LIABILITIES</i>	94,140,518	106,646,060	103,701,297	115,792,973	160,559,680
Adjustments for depreciations and amortization	17,166,288	17,026,739	19,973,901	26,197,266	30,131,804
Total debts	25,392,926	32,068,222	18,096,309	13,446,523	18,119,220
Equity ownership + Total credits	68,735,092	74,564,238	85,601,291	102,346,114	142,440,460
Current assets without stocks	38,924,531	53,910,862	49,904,973	57,040,740	69,625,620
Current assets without cash	53,018,407	52,992,910	42,299,414	69,246,623	84,660,287
Short-term debts without treasury credits	24,671,948	30,940,829	18,096,309	13,406,773	18,119,220
Reinvested profit	545,823	549,232	2,042,597	3,076,856	850,798
<i>Gross profit</i>	10,918,559	11,085,258	13,391,222	15,406,077	17,049,140
<i>Turnover</i>	139,190,732	152,697,736	156,808,447	158,289,213	158,402,223
Financial expenses	1,814,506	3,965,943	4,014,543	6,150,581	5,011,692
<i>Staff expenses</i>	48,567,245	54,681,733	53,014,636	51,080,040	50,812,704
<i>Average customers</i>	20,914,940	33,539,021	28,603,702	20,695,887	23,690,755
<i>Average suppliers</i>	13,646,335	12,130,425	9,868,463	6,306,715	8,070,447
Sales of goods	3,544,931	3,979,102	2,633,927	2,121,178	2,114,298
Expenditure on sales	3,373,578	3,646,468	2,338,554	1,862,477	1,747,424
<i>Commercial margin</i>	171,353	332,634	295,373	258,701	366,874
Sold production	135,645,801	148,718,634	154,174,320	156,168,035	156,287,925
Variation of stocks	15,015	4,460,157	1,528,153	2,678,281	1,411,944
The production made for own purposes and capitalised	1,059,268	1,640,461	1,243,304	2,117,222	1,307,998
<i>Production of the period</i>	136,720,084	154,819,252	156,945,777	160,963,538	159,007,867
Intermediary consumption	77,771,604	82,633,926	77,091,415	76,494,196	70,246,895
<i>Added value</i>	59,119,833	72,517,960	80,149,735	84,728,043	89,127,846
Income from operating subventions	0	0	0	0	0
Expenses concerning taxes	1,068,799	1,062,281	1,189,011	750,552	832,989

<i>Indicators – lei</i>	2007	2008	2009	2010	2011
<i>Operating gross profit</i>	9,483,789	16,773,946	25,946,088	32,897,451	37,482,153
Other operating income	230,647	992,006	416,247	608,765	420,627
Other operating expenses	25,203,553	21,811,685	18,356,865	14,854,952	21,729,480
<i>Operating result</i>	<i>10,021,848</i>	<i>6,666,747</i>	<i>11,405,212</i>	<i>13,858,151</i>	<i>14,503,430</i>
Taxo n operating result	1,603,496	1,066,680	1,824,834	2,217,304	2,320,549
Financial income	2,711,217	8,384,454	6,000,553	7,698,507	7,557,402
Financial result	896,711	4,418,511	1,986,010	1,547,926	2,545,710
Current result	10,918,559	11,085,258	13,391,222	15,406,077	17,049,140
Extraordinary income	0	0	0	0	0
Extraordinary expenses	0	0	0	0	0
Extraordinary result	0	0	0	0	0
Profit tax	771,691	1,581,534	3,181,235	4,129,664	5,430,844
Distributed dividends	6,662,800	10,321,284	8,402,439	7,980,813	8,460,514
Interest rate	9	8	10	8	
Current debts	24,671,948	30,940,829	18,096,309	13,406,773	18,119,220
<i>Variable expenses</i>	<i>74,732,822</i>	<i>83,829,223</i>	<i>89,526,814</i>	<i>91,537,918</i>	<i>88,624,000</i>
<i>Fixed expenses</i>	<i>55,740,992</i>	<i>65,294,390</i>	<i>59,064,125</i>	<i>58,297,412</i>	<i>58,415,362</i>
Total income	143,206,879	168,174,814	165,996,704	171,391,988	169,100,194
<i>Operating income</i>	<i>140,495,662</i>	<i>159,790,360</i>	<i>159,996,151</i>	<i>163,693,481</i>	<i>161,542,792</i>
Total expenses	132,288,320	157,089,556	152,605,482	155,985,911	152,051,054
<i>Operating expenses</i>	<i>130,473,814</i>	<i>153,123,613</i>	<i>148,590,939</i>	<i>149,835,330</i>	<i>147,039,362</i>
Staff number	1,679	1,609	1,495	1,257	1,286
<i>Invested capital cost</i>	<i>17,166,288</i>	<i>17,026,739</i>	<i>19,973,901</i>	<i>26,197,266</i>	<i>30,131,804</i>
<i>As break-even point</i>	<i>120,368,131</i>	<i>144,789,203</i>	<i>137,656,560</i>	<i>138,242,312</i>	<i>58,190,890</i>
<i>Invested capital</i>	<i>69,557,332</i>	<i>62,311,385</i>	<i>71,337,488</i>	<i>123,418,360</i>	<i>178,224,358</i>
<i>Operating net result</i>	<i>8,418,352</i>	<i>5,600,067</i>	<i>9,580,378</i>	<i>11,640,847</i>	<i>12,182,881</i>
<i>Working capital</i>	<i>28,346,459</i>	<i>22,052,081</i>	<i>24,203,105</i>	<i>55,839,850</i>	<i>66,541,067</i>

Financial balance of company A – horizontal analysis

Table no. 2

<i>Indicators - lei</i>	2007	2008	2009	2010	2011
<i>Working capital</i>	30,315,233	41,356,834	48,412,169	56,169,824	66,980,866
<i>Necessary working capital</i>	28,346,459	22,052,081	24,203,105	55,839,850	66,541,067
<i>Own working capital</i>	32,407,803	40,709,722	48,875,561	56,479,029	67,354,961
<i>Borrowed working capital</i>	-2,092,570	647,112	-463,392	-309,205	-374,095
<i>Net treasury</i>	58,661,692	19,304,753	24,209,064	329,974	439,799
<i>Self-financing capacity</i>	-15,364,097	-1,208,756	6,810,245	16,069,526	13,288,166
<i>Self-financing</i>	-22,026,897	-11,530,040	-1,592,194	8,088,713	4,827,652

The graphic evolution of the performance indicator for the analysed period is presented according to the figures 1, 2, 3, 4 and 5.

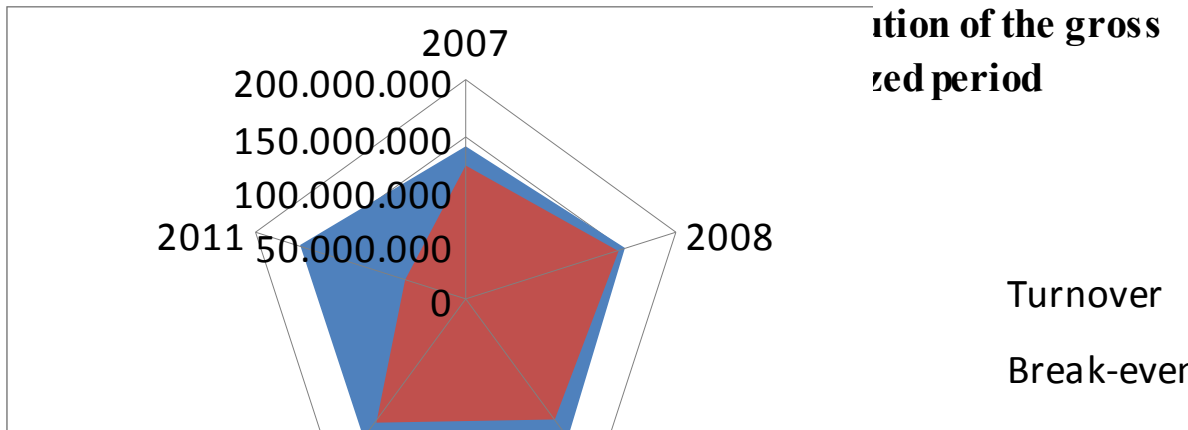
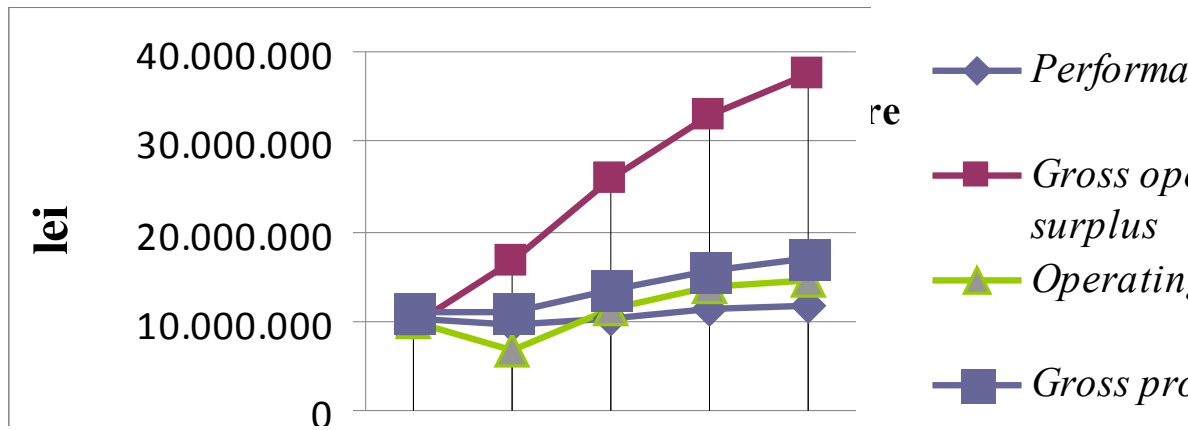
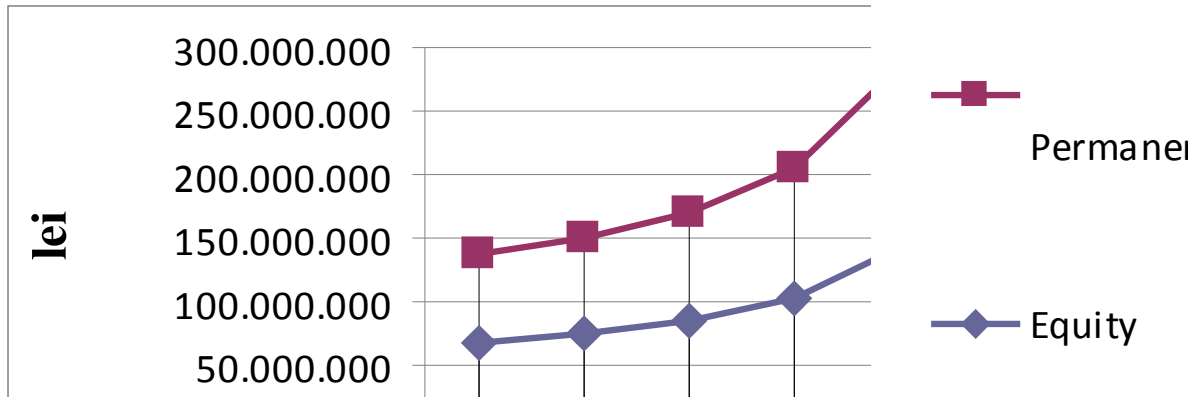
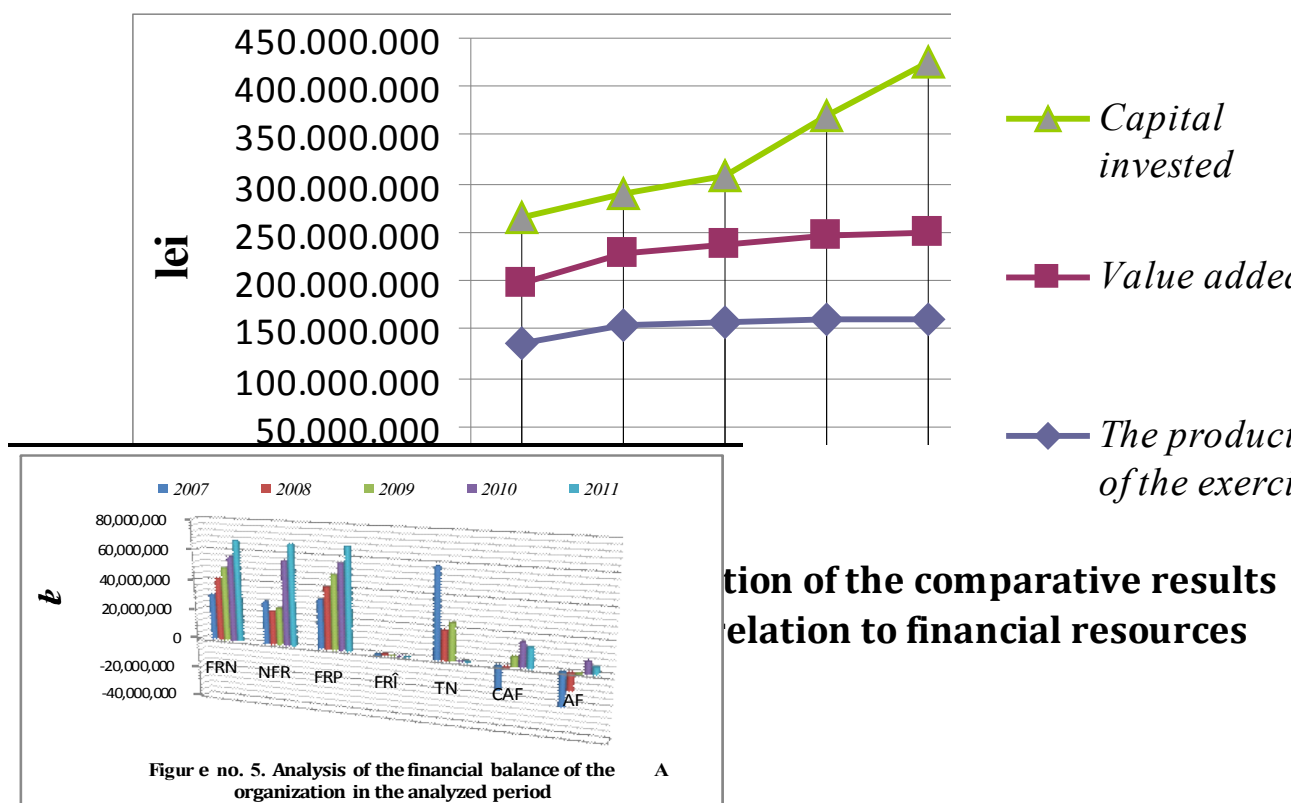


Figure no. 3 Comparative evolution of turnover and breakeven of 2007 -2011



tion of the comparative results
relation to financial resources

Organisation A is present both on the internal and external market, being one of the main suppliers of the Boeing Company. From its portfolio of products resulted form its basic activity there are:

- **Product a** - 35 Kg/ piece;
- **Product b** - 300 Kg/piece;
- **Product c** - 200 g/piece

In the analysed period, the volume of production, the practiced prices and the production costs for each category of products are the following:

Production evolution on structure and categories of costs

Table no.3

Indicators		2007	2008	2009	2010	2011
Sold quantity (piece)	Product A	300	318	300	300	308
	Product B	24	21	25	20	23
	Product C	1,034,028	922,602	804,855	824,316	807,824
Selling price (\$/Kg)	Product A	430	440	500	500	520
	Product B	450	465	500	500	500
	Product C	241	250	280	270	250
Unitary price in \$	Product A	14,000	15,400	17,500	17,500	18,375
	Product B	135,000	139,500	150,000	150,000	150,000
	Product C	48	50	56	54	50
Exchange rate		2.4	2.8	2.9	3.0	3.2
Unitary price in lei	Product A	34,020	43,582	50,750	52,500	58,800
	Product B	328,050	394,785	435,000	450,000	480,000
	Product C	117	142	162	162	160
Total expenses (lei)	Product A	9,563,731	13,048,316	14,413,321	14,908,615	16,806,599
	Product B	7,332,628	8,112,325	10,297,352	8,510,647	10,233,940
	Product C	113,577,455	127,948,060	123,880,266	126,416,068	119,998,823

Fixed expenses (lei)	Product A	4,085,815	5,713,259	5,729,220	5,800,592	6,676,876
	Product B	3,132,644	3,552,015	4,093,144	3,311,293	4,065,709
	Product C	48,522,534	56,022,587	49,241,761	49,185,527	47,672,777
Variable expenses (lei)	Product A	5,477,916	7,335,057	8,684,101	9,108,023	10,129,723
	Product B	4,199,985	4,560,310	6,204,208	5,199,354	6,168,230
	Product C	65,054,922	71,925,473	74,638,505	77,230,541	72,326,046
Turnover (lei)	Product A	10,206,000	13,859,076	15,225,000	15,750,000	18,110,400
	Product B	7,873,200	8,290,485	10,875,000	9,000,000	11,040,000
	Product C	121,111,532	130,548,175	130,708,447	133,539,213	129,251,823
Operating result (lei)	Product A	734,601	583,340	1,106,306	1,378,886	1,657,742
	Product B	563,228	362,671	790,381	787,143	1,009,439
	Product C	8,724,019	5,720,069	9,508,525	11,692,122	11,836,249
Turnover – annual average (lei)	Product A	14,630,095				
	Product B	9,415,737				
	Product C	129,031,838				
Maximum capacity of production (piece)	Product A	400	400	400	400	400
	Product B	35	35	35	35	35
	Product C	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000

Starting from the analysis of the latest data provided by the production for the year 2011, we will make a projection of the four variants, and finally, on the basis of the theory of fuzzy aggregates we will identify the decisional optimum. The first three items are: the quantity produced for each range, the proposed price and minimum imposed delivery condition, on an annual basis. The offers registered as potential contract for the period 2012-2016, differs both from the point of view of total requested quantities, of the negotiated price, but also in terms of the total amount. (Table no. 4 and figure no. 6)

The centralisation of the four offers

Table no. 4.

	Values of the contracts in lei	Quantity - pises			Year	Prises \$/Kg			Unit prizes in \$		
		a	b	c		a	b	c	a	b	c
V 1	1,217,507,420	1,867	150	6,235,000	2012	520	500	250	18,200	150,000	50
					2013						
					2014						
					2015						
					2016						
V 2	873,903,364	1,540	156	4,039,120	2012	308			18,454	152,100	51
					2013						
					2014						
					2015						
					2016						
V 3	1,135,238,126	1,704	100	5,844,140	2012	495	530	259	17,325	159,000	52
					2013						
					2014						
					2015						
					2016						
V 4	543,195,233	1,226	154	1,840,590	2012	500			17,500	144,000	74
					2013						
					2014						
					2015						
					2016						

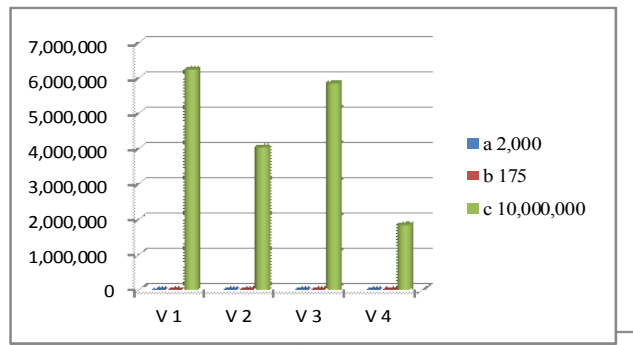


Figure no. 6 Comparing amounts requested with maximum production capacity

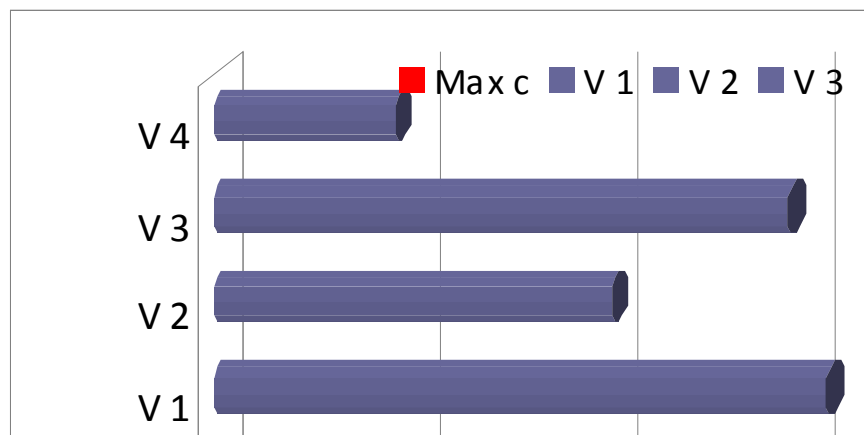


Figure no. 7 Offers for the product C

Taking into account the fact that such contracts will be carried out over a period of five years and knowing that, regardless of the version, each has a minimum annual delivery clause, it will be necessary to establish an optimal quantity per year for each range, depending on the negotiated price, the necessary resources for their production and the obtained results. (Table no. 5, 6, 7, 8)

In the case of the first variant, as it can be seen in Table No. 5, the variables that influence the evolution of the results obtained from production are: the *quantity* in number of pieces, for product *a* and *c*, which will gradually increase, and the price in dollars for products *a* and *b*, which records growth only in the recent two years, namely 2015 and 2016.

Foreseen data for the first offer

Table no.5

V1		2012	2013	2014	2015	2016
Sold quantity qv - units	Product A	350	365	372	380	400
	Product B	30	30	30	30	30
	Product C	860,000	950,000	1,230,000	1,450,000	1,745,000
Sales prices pv = \$/Kg	Product A	520	520	520	536	537
	Product B	500	500	500	515	515
	Product C	250	250	250	250	250
Unit price in \$	Product A	18,200	18,200	18,200	18,746	18,781
	Product B	150,000	150,000	150,000	154,500	154,500
	Product C	50	50	50	50	50
Exchange Rates		3.20	3.30	3.31	3.32	3.33
Unit price in lei	Product A	58,240	60,060	60,242	62,237	62,541
	Product B	480,000	495,000	496,500	512,940	514,485
	Product C	160	165	166	166	167
Total expenses Ct	Product A	19,098,408	19,916,911	20,298,879	20,735,414	21,826,752
	Product B	13,348,617	13,348,617	13,348,617	13,348,617	13,348,617
	Product C	127,749,363	141,118,483	182,711,299	215,391,368	259,212,371
Fixed costs Cf	Product A	7,587,359	7,912,531	8,064,279	8,237,704	8,671,267
	Product B	5,303,099	5,303,099	5,303,099	5,303,099	5,303,099
	Product C	50,751,888	56,063,133	72,587,003	85,570,045	102,979,123
Variable costs Cv	Product A	11,511,049	12,004,380	12,234,601	12,497,710	13,155,485
	Product B	8,045,518	8,045,518	8,045,518	8,045,518	8,045,518
	Product C	76,997,475	85,055,350	110,124,295	129,821,324	156,233,248
Turnover CA	Product A	20,384,000	21,921,900	22,410,024	23,649,954	25,016,292
	Product B	14,400,000	14,850,000	14,895,000	15,388,200	15,434,550
	Product C	137,600,000	156,750,000	203,565,000	240,700,000	290,542,500
Operating results Re	Product A	1,672,528	2,298,770	2,375,912	2,584,289	2,946,258
	Product B	1,115,018	1,671,833	1,583,941	1,938,217	2,209,694
	Product C	11,150,183	16,927,306	22,439,164	27,781,105	33,610,602
Turnover CA - annual average	Product A			22,676,434		
	Product B			14,993,550		
	Product C			205,831,500		
fill capacity of production	Product A	400	400	400	400	400
	Product B	35	35	35	35	35
	Product C	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000

Foreseen data for the second offer

Table no. 6

V2		2012	2013	2014	2015	2016
Sold quantity qv - units	Product A	308	308	308	308	308
	Product B	26	29	31	35	35
	Product C	807,824	807,824	807,824	807,824	807,824
Sales prices pv = \$/Kg	Product A	527	535	542	550	557
	Product B	507	514	521	529	536
	Product C	254	257	261	264	268
Unit price in \$	Product A	18,455	18,713	18,975	19,241	19,510
	Product B	152,100	154,229	156,389	158,578	160,798
	Product C	51	51	52	53	54
		3.300	3.303	3.307	3.310	3.313
Unit price in lei	Product A	60,901	61,815	62,743	63,685	64,641
	Product B	501,930	509,466	517,115	524,879	532,760
	Product C	167	170	172	175	178
Total expenses Ct	Product A	16,806,599	16,914,344	17,022,845	17,132,106	17,242,134
	Product B	11,568,801	12,977,829	13,956,096	15,846,451	15,948,205
	Product C	119,998,939	120,768,139	121,542,830	122,322,953	123,108,548
Fixed costs Cf	Product A	6,676,876	6,703,583	6,730,398	6,757,319	6,784,349
	Product B	4,596,019	5,144,713	5,520,100	6,254,451	6,279,469
	Product C	47,672,783	47,863,474	48,054,928	48,247,148	48,440,137
Variable costs Cv	Product A	10,129,723	10,210,761	10,292,447	10,374,787	10,457,785
	Product B	6,972,782	7,833,116	8,435,996	9,592,000	9,668,736
	Product C	72,326,056	72,904,664	73,487,902	74,075,805	74,668,411
Turnover CA	Product A	18,757,459	19,039,083	19,324,936	19,615,081	19,909,581
	Product B	13,050,180	14,774,513	16,030,568	18,370,767	18,646,586
	Product C	135,157,033	137,186,281	139,245,996	141,336,635	143,458,664
Operating results Re	Product A	2,447,212	2,627,157	2,812,895	2,999,711	3,192,833
	Product B	1,704,114	2,039,410	2,332,645	2,807,773	2,988,538
	Product C	17,640,409	18,937,717	20,264,533	21,612,177	23,003,574
Turnover CA - annual average	Product A			19,329,228		
	Product B			16,174,523		
	Product C			139,276,922		
fill capacity of production	Product A	400	400	400	400	400
	Product B	35	35	35	35	35
	Product C	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000

The second variant is different from the first by the fact that it registers higher prices for all the products in the organisation's portfolio, for all the contracting period, the produced quantity being constant, except for product *b*.

Foreseen data for the third offer

Table no. 7

V 3		2012	2013	2014	2015	2016
Sold quantity <i>qv</i> - units	Product A	304	300	325	400	375
	Product B	20	20	20	20	20
	Product C	737,200	980,565	1,264,850	1,350,689	1,510,836
Sales prices <i>pv</i> = \$/Kg	Product A	495	510	545	580	590
	Product B	530	550	504	500	515
	Product C	259	260	277	284	270
Unit price in \$	Product A	17,325	17,850	19,075	20,300	20,650
	Product B	159,000	165,000	151,200	150,000	154,500
	Product C	52	52	55	57	54
		3.30	3.10	3.18	3.04	3.00
Unit price in lei	Product A	57,173	55,335	60,659	61,712	61,950
	Product B	524,700	511,500	480,816	456,000	463,500
	Product C	171	161	176	173	162
Total expenses <i>Ct</i>	Product A	16,588,332	16,370,064	19,280,005	21,826,752	20,462,580
	Product B	8,899,078	8,899,078	11,580,917	8,899,078	8,899,078
	Product C	109,507,943	145,658,784	184,767,930	200,639,139	224,428,299
Fixed costs <i>Cf</i>	Product A	6,590,163	6,503,451	7,045,405	8,671,267	8,129,313
	Product B	3,535,399	3,535,399	3,535,399	3,535,399	3,535,399
	Product C	43,504,991	57,866,890	74,643,635	79,709,323	89,160,209
Variable costs <i>Cv</i>	Product A	9,998,168	9,866,614	12,234,601	13,155,485	12,333,267
	Product B	5,363,679	5,363,679	8,045,518	5,363,679	5,363,679
	Product C	66,002,952	87,791,894	110,124,295	120,929,817	135,268,089
Turnover <i>CA</i>	Product A	17,380,440	16,600,500	19,714,013	24,684,800	23,231,250
	Product B	10,494,000	10,230,000	9,616,320	9,120,000	9,270,000
	Product C	126,016,968	158,067,078	222,831,154	233,226,171	244,755,432
Operating results <i>Re</i>	Product A	2,116,247	1,396,182	2,031,202	1,581,805	920,873
	Product B	683,372	583,172	1,109,013	1,005,186	661,208
	Product C	19,222,579	15,174,473	36,617,289	36,373,720	25,187,486
Turnover <i>CA</i> - annual average	Product A	20,322,201				
	Product B	9,746,064				
	Product C	196,979,361				
Full capacity of production	Product A	400	400	400	400	400
	Product B	35	35	35	35	35
	Product C	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000

In the case of the third variant, the only constant is registered from a quantitative point of view for product *b*, whose price cannot be assessed due to the estimation of a surplus of offers.

The forecast of the production structure for the fourth offer

Table no. 8

V 4		2012	2013	2014	2015	2016
Sold quantity qv - units	Product A	219	280	235	267	225
	Product B	32	29	26	33	34
	Product C	350,210	374,563	361,780	372,823	381,214
Sales prices pv = \$/Kg	Product A	500	500	500	500	500
	Product B	480	472	469	499	510
	Product C	370	355	341	327	314
Unit price in \$	Product A	17,500	17,500	17,500	17,500	17,500
	Product B	144,000	141,600	140,700	149,700	153,000
	Product C	74	71	68	65	63
		3.22	3.20	3.21	3.20	3.19
Unit price in lei	Product A	56,350	56,000	56,175	56,000	55,825
	Product B	463,680	453,120	451,647	479,040	488,070
	Product C	238	227	219	210	200
Total expenses Ct	Product A	11,950,147	15,278,726	12,823,217	14,569,357	12,277,548
	Product B	14,238,525	12,903,663	11,568,801	14,683,479	15,128,432
	Product C	52,022,215	55,639,750	53,740,889	55,381,280	56,627,728
Fixed costs Cf	Product A	4,747,519	6,069,887	5,094,370	5,788,071	4,877,588
	Product B	5,656,639	5,126,329	4,596,019	5,833,409	6,010,179
	Product C	20,667,231	22,104,395	21,350,021	22,001,711	22,496,896
Variable costs Cv	Product A	7,202,628	9,208,839	7,728,847	8,781,286	7,399,960
	Product B	8,581,886	7,777,334	6,972,782	8,850,070	9,118,254
	Product C	31,354,983	33,535,355	32,390,868	33,379,569	34,130,832
Turnover CA	Product A	12,340,650	15,680,000	13,201,125	14,952,000	12,560,625
	Product B	14,837,760	13,140,480	11,742,822	15,808,320	16,594,380
	Product C	83,448,039	85,148,658	79,199,743	78,108,463	76,432,168
Operating results Re	Product A	4,775,540	4,434,129	4,189,021	4,063,738	3,802,800
	Product B	1,354,258	1,108,532	861,572	479,747	439,780
	Product C	29,508,559	28,049,227	24,629,069	23,676,918	21,626,808
Turnover CA - annual average	Product A			13,746,880		
	Product B			14,424,752		
	Product C			80,467,414		
Full capacity of production	Product A	400	400	400	400	400
	Product B	35	35	35	35	35
	Product C	2,000,000	2,000,000	2,000,000	2,000,000	2,000,000

The last offer shows variations in production structure both in terms of quantity and value terms, aspect that is not identified with the preset objectives at a managerial level, as practicing constant prices leads to the keeping of the position on the market for a short time, if it is not balanced by an appreciation of the amount expressed in number of pieces, while the decline of the price, from one period to another, up to the limit of threshold of significance, cannot lead to the elimination of that product from the portfolio, considered unperforming.

2.2 The Determination of the Optimal Decision Using the Algorithm of the Vague Aggregate Theory

The definition of areas and memory variables. For the four decisional alternatives the memory variable is N=4, concerning the memory variable of economic criteria, there is established that M=9. The construction of the absolute consequence matrix of the N alternatives according those M criteria is presented as follows: (Table no. 9)

Alternative decisions

Table no. 9

Criteria	Indicators	U.M.	Alternative decisions for 2012-2016			
			V1	V2	V3	V4
C1	Turnover	lei	1,217,507,420	873,903,364	1,135,238,126	543,195,233
C2	Net profit	lei	114,240,281	112,439,916	124,713,616	126,940,514
C3	Operating expenses	lei	1,094,802,333	763,156,718	1,006,707,057	408,833,756
C4	Value added	lei	649,345,580	482,487,934	613,856,003	342,243,634
C5	Critical turnover	lei	950,222,665	639,467,915	854,328,012	305,157,757
C6	The net result of exploitation	lei	111,136,048	107,024,986	121,527,996	128,544,701
C7	Labor productivity	lei	968,582	695,229	903,133	445,389
C8	Critical point (operational risk)	days	221	282	353	341
C9	The capacity uptake of the production in the critical po	%	88	77	76	91

The nature of the criteria taken into consideration T (M) classifies them as follows: C1, C2, C4, C6, C7 and C9 Maxim criteria, and C3, C5 and C8 Minimum criteria. (Table no. 10)

The nature of criteria according to which the selection of an alternative is made

Table no.10

Criteria	Indicators	Nature of the criteria
C1	Turnover	Maximum
C2	Net profit	Maximum
C3	Operating expenses	Minimum
C4	Value added	Maximum
C5	Critical turnover	Minimum
C6	The net result of exploitation	Maximum
C7	Labor productivity	Maximum
C8	Critical point (operational risk)	Minimum
C9	The capacity uptake of the production in the critical point	Maximum

Affiliation coefficients K(M) reflects the importance given by the decision-maker, from a scale from 2 to 6, to those 9 selection criteria. (Table no. 11).

The list of affiliation coefficients set by the decision-maker in order to select the optimal decisional alternative

Table no. 11

Criteria	Indicators	Factor of affiliation K _j
C1	Turnover	5.5
C2	Net profit	5.8
C3	Operating expenses	4.7
C4	Value added	5
C5	Critical turnover	5.4
C6	The net result of exploitation	4.4
C7	Labor productivity	3
C8	Critical point (operational risk)	5
C9	The capacity uptake of the production in the critical point	2.5

The matrix of absolute consequences CA(4, 9) present the effective (forecast) values registered by each decisional variant, for each of those pre-established 9 criteria. (Table no.12)

The matrix of absolute consequences

Table no. 12

		j								
CA (4, 9)		C1	C2	C3	C4	C5	C6	C7	C8	C9
i	V1	1,217,507,420	114,240,281	1,094,802,333	649,345,580	950,222,665	111,136,048	968,582	221	88
	V2	873,903,364	112,439,916	763,156,718	482,487,934	639,467,915	107,024,984	695,229	282	77
	V3	1,135,238,120	124,713,616	1,006,707,051	613,856,003	854,328,012	121,527,994	903,133	353	76
	V4	543,195,233	126,940,514	408,833,756	342,243,634	305,157,757	128,544,701	445,389	341	91
	$\sum C_{aij}$	3,769,844,141	478,334,327	3,273,499,864	2,087,933,151	2,749,176,341	468,233,731	3,012,333	1,197	332

Applying the formula (no. 1) on the elements of the consequence matrix, we obtain the matrix of relative consequences for the set of given alternatives and criteria (Table no. 13)

The matrix of relative consequences

Table no. 13

		Stage I								
CR (4, 9)		C1	C2	C3	C4	C5	C6	C7	C8	C9
V1		0.32	0.24	0.33	0.31	0.35	0.24	0.32	0.18	0.27
V2		0.23	0.24	0.23	0.23	0.23	0.23	0.23	0.24	0.23
V3		0.30	0.26	0.31	0.29	0.31	0.26	0.30	0.29	0.23
V4		0.14	0.27	0.12	0.16	0.11	0.27	0.15	0.28	0.27

Using the formula (no.2) we calculate the elements of the helping matrix, obtaining thus Z (4, 9) with the following data (Table no.14):

Helping matrix

Table no. 14

		Stage II								
Z (4, 9)		C1	C2	C3	C4	C5	C6	C7	C8	C9
V1		0.00	0.10	1.68	0.00	2.11	0.14	0.00	0.00	0.00
V2		0.28	0.11	0.87	0.26	1.10	0.17	0.28	0.28	0.13
V3		0.07	0.02	1.46	0.05	1.80	0.05	0.07	0.60	0.14
V4		0.55	0.00	0.00	0.47	0.00	0.00	0.54	0.54	0.03

The calculation of the elements of the characteristic functions' matrix FC (4, 9) using the calculation formula (3.), represents in fact the fuzzyfication of the helping matrix elements, according to the affiliation coefficient of each criterion to the interval [0, 1], in order to the degree in which the four offers meet the selection criteria. (Table no. 15)

The matrix of characteristic functions

Table no. 15

		Stage III								
FC (4, 9)		C1	C2	C3	C4	C5	C6	C7	C8	C9
V1		1.000	0.549	0.000	1.000	0.000	0.549	1.000	1.000	1.000
V2		0.202	0.497	0.017	0.273	0.003	0.497	0.449	0.247	0.741
V3		0.670	0.905	0.001	0.741	0.000	0.819	0.819	0.050	0.741
V4		0.050	1.000	1.000	0.091	1.000	1.000	0.202	0.067	0.905

In the last stage based on the formulas (4, 5, 6, 7), which represent the pessimist or prudence technique (Abraham Wald), the balance technique (Bayes – Laplace) and the optimality technique (Leonid Hurwicz) there is established the optimal alternative.

The technique of balance or equiprobability (Bayes-Laplace)

Table no. 16

FC	C1	C2	C3	C4	C5	C6	C7	C8	C9	max 1/n x Σ Fcij	Σ Fcij
V1	1.000	0.549	0.000	1.000	0.000	0.549	1.000	1.000	1.000	1.525	6.098
V2	0.202	0.497	0.017	0.273	0.003	0.497	0.449	0.247	0.741	0.731	2.924
V3	0.670	0.905	0.001	0.741	0.000	0.819	0.819	0.050	0.741	1.186	4.745
V4	0.050	1.000	1.000	0.091	1.000	1.000	0.202	0.067	0.905	1.329	5.314

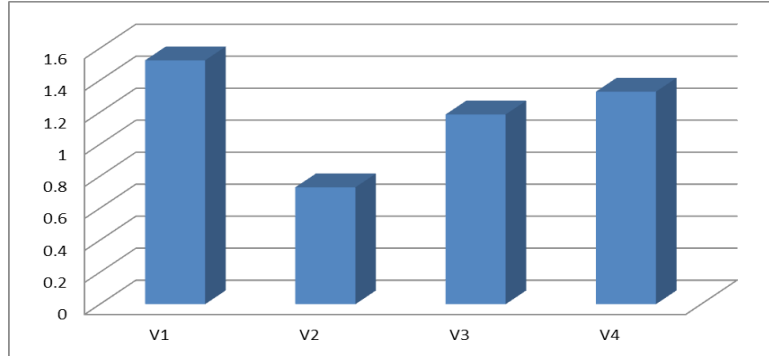


Figure no. 9 Hierarchy of decision alternatives using the technique Bayes-Laplace

The pessimist or prudence technique (Abraham Wald)

Table no. 17

FC	C1	C2	C3	C4	C5	C6	C7	C8	C9	min j Fcij
V1	1.000	0.549	0.00037	1.000	0.00001	0.549	1.000	1.000	1.000	0.00001
V2	0.202	0.497	0.017	0.273	0.003	0.497	0.449	0.247	0.741	0.00274
V3	0.670	0.905	0.001	0.741	0.0001	0.819	0.819	0.050	0.741	0.00006
V4	0.050	1.000	1.000	0.091	1.000	1.000	0.202	0.067	0.905	0.04979

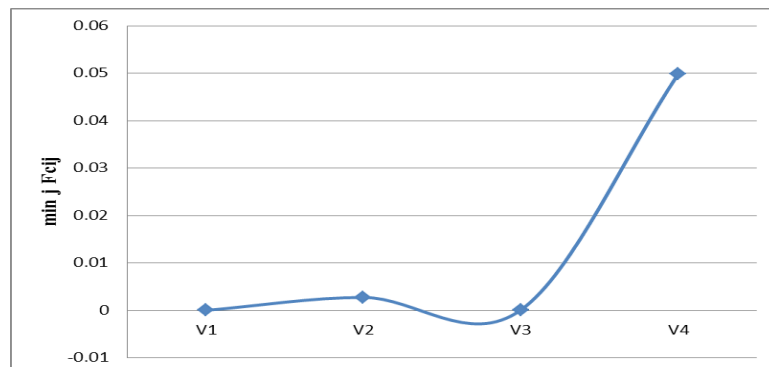


Figure no. 10 Hierarchy of decision alternatives using pessimistic technique Abraham Wald

The optimality technique (Leonid Hurwicz)

Table no. 18

FC (4, 9)	C1	C2	C3	C4	C5	C6	C7	C8	C9	$\alpha = 0.15$
										$\alpha x Ai + (1 - \alpha) x ai$
V1	1.000	0.549	0.00037	1.000	0.00001	0.549	1.000	1.000	1.000	0.150010
V2	0.202	0.497	0.017	0.273	0.003	0.497	0.449	0.247	0.741	0.113451
V3	0.670	0.905	0.001	0.741	0.0001	0.819	0.819	0.050	0.741	0.135778
V4	0.050	1.000	1.000	0.091	1.000	1.000	0.202	0.067	0.905	0.192319

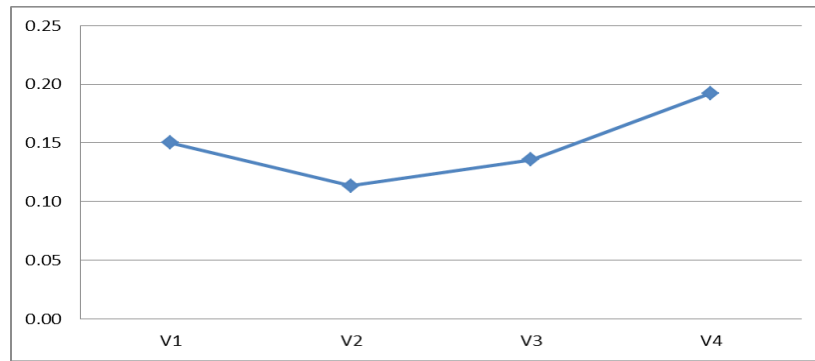


Figure no.11 Technique using optimality ranking decision alternatives Leonid Hurwitz

Centralising the results of the application of the three techniques, the best action variant is obtained, according to which the company management decides if this will be implemented.

The comparative analysis of the results of applying the multicriteria optimization techniques

Table no. 19

Poziition	Technique		
	Laplace	Pessimistic	Optimality ($\alpha = 0.15$)
1	V1	V1	V4
2	V4	V3	V1
3	V3	V2	V3
4	V2	V4	V2

Conclusion

In conclusion, if the company management wishes to adopt a balanced approach, it will proceed to contracting offer V1, which corresponds to all requirements imposed initially, characterised at the same time by a minimum degree of risk, almost inexistent.

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