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How to Deal with Multi-sequential Decision-making Processes

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In the present paper, the types of decisions being taken at the top management level of a company, aim at its development and its manifestation on the competitive market, in the long run. These strategic decisions are adopted more in the conditions of risk and uncertainty determined by the forecast of market evolution.

Keywords: *Decisional tree, states of nature, decisional variants, expected value, additional information, risk conditions, uncertainty conditions*

1. Introduction

In the activity of industrial companies, the managerial decision will have to take into account two approaches essential to establishing a strategy [5], namely:

- Competition and market;
- Profitability in the chosen market.

The decision-making strategies possible in the case of achieving a construction objective consist in choosing a process to build a large, medium and small capacity construction objective, and the nature states associated with each strategy can be: favorable, favorable or unfavorable environment [7].

The decision-making process in this case is represented by a tree-type graph, consisting of decision-type nodes, event type and end nodes, as well as nature state-type branches and decision-making variants.

The decisional tree method is based on the graphical representation of all the possible combinations of decisional variants and the states of nature corresponding to each moment, being a very useful tool for decision making [6].

The identification of several decisional variants, of some nature states, and the decisional criterion lead to the realization of a decisional model in uncertain conditions. In order to determine the optimal decision, we use the most known decision criteria, namely: the Wald criterion (the pessimistic rule), the Laplace criterion (the rule of balance), the Savage criterion (the rule of regrets), the Hurwics criterion (the rule of optimality) and the maxi max criterion optimistic rule) [2].

2. Methods and materials

The general manager of a company wishes to increase production capacity, proposing to take into account three main issues, namely:

- V1 – to build a large production hall;
- V2 – to build a small production hall;
- V3 – give up the idea of building the hall;

Some probabilities, determined by experts, based on the experience gained, but also on the basis of customer demand, are taken into account.

Thus, in the case of building a large production hall, the market response can be favorable (SF) or unfavorable (SNF), with a probability of 30% and an estimated profit of 500.000 u.m., respectively a loss of 380.000 u.m. There is also a favorable medium-market situation (SM), with a slightly higher probability of 40%, with the estimated profit being 350.000 u.m.

If the production hall to be built is small, the market response may be favorable or unfavorable, with a probability of 30% and an estimated profit of 200.000 u.m., respectively a loss of 120.000 u.m., and in the case of the favorable average market, the probability being 40%, the estimated profit would amount to 150.000 u.m.

The general manager of the firm asks for an optimal version, based on the information provided and presented in Table 1.

Table 1. Input data

Alternatives	**States of nature**		
	SF	**SM**	**SNF**
V1	500.000 u.m	350.000 u.m	-380.000 u.m
V2	200.000 u.m	150.000 u.m	-120.000 u.m
V3	0	0	0
Probabilities	0.3	0.4	0.3

In accordance with the decisional alternatives, the problem decision tree can be made (fig.1).

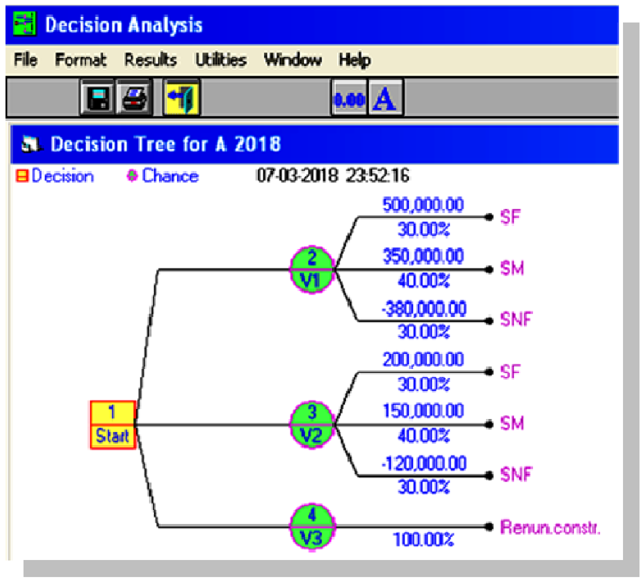

Figure 1. Decisional tree

The result obtained from the use of WinQSB software is shown in Figure 2. It can be seen that the best optio is building a large hall.

07-03-2018	Node/Event	Type	Expected value	Decision
1	Start	Decision node	$176,000	V1
2	V1	Chance node	$176,000	
3	V2	Chance node	$84,000.01	
4	V3	Chance node	0	
5	SF	End node	$500,000	
6	SM	End node	$350,000	
7	SNF	End node	($380,000)	
8	SF	End node	$200,000	
9	SM	End node	$150,000	
10	SNF	End node	($120,000)	
11	Renun.constr.	End node	0	
Overall	Expected	Value =	$176,000	

Figure 2. Decisional tree analysis

For greater confidence in this resolution, we use the services of a market research firm. The cost of this study is 3.000 u.m. and leads to the following probabilities:

Case 1 - the results of the construction of the production hall are favorable in a proportion of 45%;

Case 2 - the results of the construction hall are 55% unfavorable.

However, for the V1 variant, the market would be 70% favorable and the profit would be 250.000 u.m. and in the second case, the market would be 40% favorable, which would bring a profit of 150.000 u.m.

In case of option 3, namely the renunciation of the construction of the hall, the market must be both favorable and unfavorable in proportion of 50%.

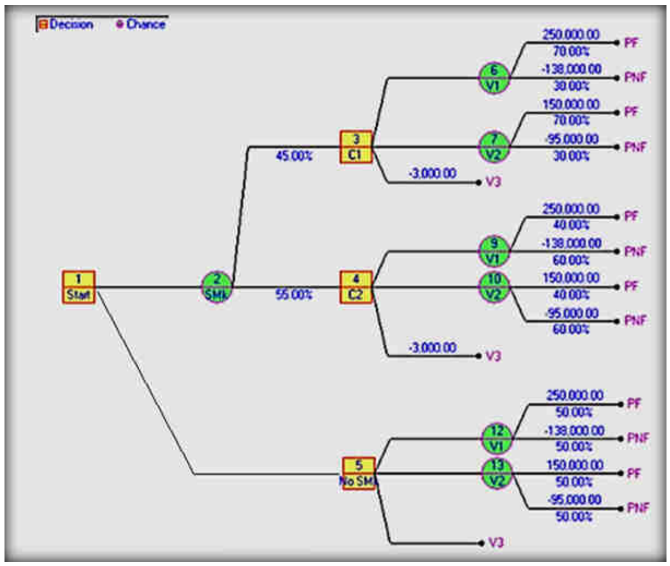

Figure 3. Graphic representation of the decision tree

Choosing the optimal decisional variant using the decisional tree method, as well as the expected values in the nodes in which the branches of the tree converge and the ones that have represented the decisional alternatives, are illustrated in Figure 4.

According to the decisional tree analysis (fig.4), the best option for the initial decision is the marketing study (SMk). Again variant 1 is given as the optimal one, namely the construction of the large production hall. The expected average profit is 69.580 u.m. equal to the decision node value 1.

07-04-2018	Node/Event	Type	Expected value	Decision
1	Start	Decision node	$69,580	SMk
2	SMk	Chance node	$69,580	
3	C1	Decision node	$133,600	V1
4	C2	Decision node	$17,200.00	V1
5	No SMk	Decision node	$56,000	V1
6	V1	Chance node	$133,600	
7	V2	Chance node	$76,500	
8	V3	End node	($3,000)	
9	V1	Chance node	$17,200.00	
10	V2	Chance node	$3,000.00	
11	V3	End node	($3,000)	
12	V1	Chance node	$56,000	
13	V2	Chance node	$27,500	
14	V3	End node	0	
15	PF	End node	$250,000	
16	PNF	End node	($138,000)	
17	PF	End node	$150,000	
18	PNF	End node	($95,000)	
19	PF	End node	$250,000	
20	PNF	End node	($138,000)	
21	PF	End node	$150,000	
22	PNF	End node	($95,000)	
23	PF	End node	$250,000	
24	PNF	End node	($138,000)	
25	PF	End node	$150,000	
26	PNF	End node	($95,000)	
Overall	Expected	Value =	$69,580	

Figure 4. Results of the decision tree analysis

The company manager also wants to make an analysis of the economic consequences of launching a new product on the market, whose sales price is estimated at 17 u.m.

In this sense, three states of nature and three decisional variants are identified, namely:

S1 - favorable market; the product is sold in 100 thousand pieces;

S2 - favorable medium market; the product is sold in 65 thousand pieces;

S3 - unfavorable market; the product is sold in 15 thousand pieces;

V1 - the product is manufactured in the current location; the fixed costs being 55 thousand u.m. and the unitary variable cost of 15 u.m;

V2 - the product is manufactured in the new large hall; the fixed costs being 105 thousand u.m. and the unitary variable cost of 14 u.m;

The expected economic consequences are cost-type and profit-type.

In the case of cost-related consequences, according to the results presented in Figure 5, the expected value without additional information is 945 thousand u.m., and the one with perfect information is 933,33 thousand u.m. The value of perfect information is 11,67 thousand u.m. and represents the difference between the two previously presented values.

It is noted that the results obtained indicate the second alternative (V2), namely the manufacture of the product in the new large hall, as the best.

07-13-2018 Criterion	Best Decision	Decision Value	
Maximin	V2	($1,505)	
Maximax	V1	($280)	
Hurwicz (p=0.7)	V1	($662.50)	
Minimax Regret	V2	$35	
Expected Value	V2	($945)	
Equal Likelihood	V2	($945)	
Expected Regret	V2	$11.67	
Expected Value	without any	Information =	($945)
Expected Value	with Perfect	Information =	($933.33)
Expected Value	of Perfect	Information =	$11.67

Figure 5. Table results - costs variant

Figure 6 shows the values resulting from the application of the different decisional criteria.

07-13-2018 Alternative	Maximin Value	Maximax Value	Hurwicz (p=0.7) Value	Minimax Regret Value	Equal Likelihood Value	Expected Value	Expected Regret
V1	($1,555)	($280)**	($662.50)**	$50	($955.00)	($955.00)	$21.67
V2	($1,505)**	($315)	($672)	$35**	($945)**	($945)**	$11.67**

Figure 6. The results of the decisional criteria - the Costs option

For the case of consequences of profits type, the decision-making model under uncertainty conditions is presented in matrix form in fig.7.

Decision \ State	State1	State2	State3
Prior Probability	0	0	0
Alternative1	145	75	-25
Alternative2	195	90	-60

Figure 7. Input table of the problem - type profit

For profit variant, the maximum values of the expected values or calculated averages are chosen (fig.8). The results obtained for this variant of consequences identify the variant 2 as the most suitable, namely the manufacture of the product in the new large hall (fig.9).

07-12-2018 Alternative	Maximin Value	Maximax Value	Hurwicz (p=0.7) Value	Minimax Regret Value	Equal Likelihood Value	Expected Value	Expected Regret
Alternative1	($25)**	$145	$94	$50	$65.00	$65	$21.67
Alternative2	($60)	$195**	$118.50**	$35**	$75**	$75**	$11.67**

Figure 8. The results of the decision criteria - the profit variant

07-12-2018 Criterion	Best Decision	Decision Value	
Maximin	Alternative1	($25)	
Maximax	Alternative2	$195	
Hurwicz (p=0.7)	Alternative2	$118.50	
Minimax Regret	Alternative2	$35	
Expected Value	Alternative2	$75	
Equal Likelihood	Alternative2	$75	
Expected Regret	Alternative2	$11.67	
Expected Value	without any	Information =	$75
Expected Value	with Perfect	Information =	$86.67
Expected Value	of Perfect	Information =	$11.67

Figure 9. Results in table form – Profit variant

The expected profit without additional information is 75 thousand u.m., and the one with the perfect information is 86,67 thousand u.m.

3. Conclusions

The decision-maker often lacks information, making it difficult to make the best decision. In such cases, only intuition can be used, and in many cases, the decisions thus taken prove to be not the best.

The level of uncertainty or risk is determined by the level of information. For decisions taken under uncertainty, the risks are assumed without knowing the likelihood of their realization.

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