AN APPLICATION OF THE ELECTRE METHOD FOR THE CHOICE OF TRAVEL INSURANCES

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Abstract: In the last decades, mathematical models are used for solving various decisional situations. Specific software applications are developed in order to implement decisional models. The paper presents the use of Electre method for supporting the choice of a travel insurance. The problem is a typical multicriterial decision problem and is solved through a specific implementation of the "Electre" software developed at "Aurel Vlaicu" University from Arad. The case study is based on the personalized choice of a flight insurance and proofs the utility of the software in real situations.

Keywords: Multicriterial decision, Electre method, Travel insurance.

1. Introduction

Choosing the best solution to a decision problem is not always at the tip of the fingers and has to be scientifically proved. Decision theory refers to mathematical models that help decision maker to solve complex problems involving several criteria (Nagy, Vizental, Ghazal & Lile, 2006). Multiattribute decision making refers to decision making in the presence of various elements, which are usually contradictory.

Multiattribute decision problems are very different, depending on the situation generating the decision. They present some common features, of which the most important are: alternatives, multiple attributes, the conflict between attributes, incompatibility of the attributes, criteria, weights of criteria and the structure of the decision matrix. (Gass, 1985)

Among the common models in practice, we chose the particular case of multiattribute decision that can be solved by using the "Electre" model. The software application made within the Department of Mathematics and Computer Sciences at "Aurel Vlaicu" University of Arad bears with a high level of generality, thus it can be adapted to solve various decision problems of real life. The case study in this paper is taken from the field of life insurance while the decision maker is the client of a flight insurance.

2. The general characteristics of flight insurances

Life insurances were developed in the last decades and currently are determined by the various needs of customers. Insurance companies offer a wide range of life insurance products, each covering different risks and bearing different names.

Travel insurance policy provides coverage for specific events occurring on various travels, especially by air, for example: loss of baggage, trip cancellation, illness or injury, medical assistance. Depending on the flight, company, period, purpose of travel or destination, the flight insurance may cover the following risks: cancellation or trip interruption; loss, theft or damage of luggage; delayed luggage; missed take-off; missed connection; trip delay; emergency medical expenses; repatriation in case of illness or accident; repatriation in case of death; death in accident; disability from and accident; legal expenses, etc.

Among the factors to take into account by the beneficiary of insurance are: the price of insurance; assured sum; the expected services; the prestige and the confidence of the insurer; validity of the policy in time; area of the validity - Europe, all over the world, excepted countries, etc.; maximum age for completion of insurance; other restrictive conditions.

Typically, each flight company works with one or more insurance companies. Nowadays, when the air transportation is a whole industry focused on profit where the "refutes" can't be excluded, the quality of insurances offered to potential customers is important. Moreover, modern man has already the culture of insurance - life, car, house, field crops, etc, thus insurance while traveling by plane should be part of the offer of any insurer. Under these conditions, a comparison between different types of insurance is very important. (www.asigura.ro)

3. The model

ELECTRE method (Elimination et Choix Traduisant la Réalité), proposed by Bertrand Roy in 1967, is a useful tool for optimizing the decisions in conditions of certainty. Electre method can be used in typical situation when there are a certain number of alternatives / action variants to reach the goal V^i (i=1, m), the evaluation being performed on the basis of a number of criteria C^j (j=1,n) while comparing the alternatives two by two. (Ionescu, Cazan & Negruşa, 2001).

Step 1

For the target to achieved, the decision maker will establish:

- the Variants – the Alternatives or possible action courses V^i (i=1, m);
- the Criteria – the attributes to be considered while evaluating the alternatives C^j (j=1, n);
- the type of evaluation – quantitative or qualitative.

Step2

Each Alternative is evaluated according to the Criteria and the qualifiers are used to build the decision matrix.

$$M = \begin{array}{c} \\ V_1 \\ V_2 \\ \cdots \\ V_m \end{array} \begin{array}{c} \begin{array}{cccc} C^1 & C^2 & \dots & C^n \end{array} \\ \begin{pmatrix} G & VG & \dots & B \\ VB & B & \dots & S \\ \dots & \dots & \dots & \dots \\ B & G & \dots & S \end{pmatrix} \end{array}$$

Step 3

A linear numeric scale is used for each criteria and the qualifiers in the matrix are replaced with the corresponding values v_{ij}.

$$M^1 = \begin{array}{c} \\ V_1 \\ V_2 \\ .... \\ V_m \end{array} \begin{array}{c} \begin{array}{cccc} C^1 & C^2 & \ldots & C^n \end{array} \\ \begin{pmatrix} v_{11} & v_{12} & \ldots & v_{1n} \\ v_{21} & v_{22} & \ldots & v_{2n} \\ \ldots & \ldots & \ldots & \ldots \\ v_{m1} & v_{m2} & \ldots & v_{mn} \end{pmatrix} \end{array}$$

Step 4

The importance of each Criterion is given by a numeric value that will be used to weighting the criteria. The sum of all weights must be 1 or 100 (depending on the scale)

$K^j = (K^1 \quad K^2 \quad \ldots \quad \ldots K^n)$, $(j=1, n)$

Step 5

The values in the matrix M^1 are multiplied by the coefficients K_j , obtaining the homogenous matrix $M^2 = (N^{ij})$ i=1,n; j=1,m, cu $N^{ij} = K^j * v^{ij}$

$$M^2 = \begin{array}{c} \\ V_1 \\ V_2 \\ .... \\ V_m \end{array} \begin{array}{c} \begin{array}{cccc} C^1 & C^2 & \ldots & C^n \end{array} \\ \begin{pmatrix} N_{11} & N_{12} & \ldots & N_{1n} \\ N_{21} & N_{22} & \ldots & N_{2n} \\ \ldots & \ldots & \ldots & \ldots \\ N_{m1} & N_{m2} & \ldots & N_{mn} \end{pmatrix} \end{array}$$

$K^i \quad (K^1 \quad K^2 \quad \ldots K^n)$

Step 6

The matrix of concordance and the matrix of discordance are computed. The concordance matrix is (m,m) and its elements $C_{i,j}$ express the superiority of the Alternative “*i*” with respect to Alternative “*j*”.

$$c^{ij} = \frac{\sum_{conc=1}^{m} K_J}{\sum_{j=1}^{m} K_j} \quad , \quad \text{where:}$$

- $\sum_{conc=1}^{m} K_j$ - the sum of the K_j for which the elements corresponding to *Vi* (in the homogenous matrix M_2) are greater or equal to the elements corresponding to V_j .
- $\sum_{j=1}^{m} K_j$ - the sum of K_j (1 or 100).

The discordance matrix is (m,m) too, being computed as:

$$d^{ij} = \frac{\max(\delta d)}{h_m} \quad , \quad \text{where:}$$

- h^m - the difference between the highest and lowest score in the homogenous matrix M_2.

- max(δd) – is the maximum of the scores corresponding to Vi and Vj for the same criteria.

Step 7

The final ranking for the Alternatives is established according to a surclass relation determined by the differences:

if $c^{ij} - d^{ij} > c^{ji} - d^{ji}$ then Alternative V^i is a better decision better then Alternative V^j.

4. Using the "Electre" software for solving the model

Lets' consider a potential client for a flight insurance, age between 30 and 40, traveling 4 - 7 times a year using international flights, for business or pleasure, having a family and income slightly over the media. The data source are the common insurance contracts available on the Romanian market.

Figure 1 – The main menu of the application

In order to solve the problem, we properly adapted the "Electre" application designed at the Department of Mathematics and Computer Science at "Aurel Vlaicu" University from Arad. Figure 1 presents the main menu that controls all the actions of the program. (Nagy & Varlan, 2001)

4.1. The input data

Considering the available flight insurances offered by various companies independently or in packages, an analysis revealed the main criteria suitable for the comparison of the products. The analysis included products offered by: AIG, Tarom and AIG, Vola and AIG, eSky, CityInsurance, WizzAir, Astra, Allianz-Tiriac. (www.portaldeasigurari.ro)

The Alternatives are the products offered by most of the companies. The Alternatives (Vi) are denoted in the program as Ai:

- A1 – International travel insurance
- A2 – Flight insurance
- A3 – Package of flight insurance - basic
- A4 – Package of flight insurance – plus
- A5 – Package of flight insurance - extra

The common clauses found in all the contracts are used for applying a simplified model. The Criteria (Ci) are denoted in the program as Xi. The considered criteria are:

- X1 – Price of the contract (Ron)
- X2 – Insurance period – number of the days before/after the flight
- X3 – The amount of insurance (Ron)
- X4 – Compensation for luggage delay – number of days in delay
- X5 – Loss of theft of luggage
- X6 – Illness or accident
- X7 – Covering of the medical expenses – full or partly, in Schengen countries or allover the world
- X8 – Death
- X9 – Repatriation in case of illness or death
- X10 – The maximum age of the insured person.

The first four criteria are quantitative, expressed by numbers, while the rest are qualitative being described in common language. X1 is a criterion "best if minim" and the rest are "best if maxim" – the advantage of the client is to pay as less as possible for as much benefits as possible.

For establishing the weights – the importance of each criterion, we used information available from insurance companies, travelers, posted on the Internet or written in the insurance contracts. We considered the "standard traveler" for this example: male, age 30 – 40 that flights 4-7 times a year for business or pleasure, mostly in Europe, has 2 children and income slightly above media. For such a subject, important are the price, the insured amount, compensation for the lost or delay of language. Due to his youth and specific way of thinking, less important are the criteria connected to medical expenses, death or repatriation.

The weights (Ki) are denoted in the program with Ci. The result of the evaluation (Ioan & Ioan, 2011) give the following values:

- C1 – 25%
- C2 – 15%
- C3 – 10%
- C4 – 15%
- C5 – 15%
- C6 – 8%
- C7 – 1%
- C8 – 0%
- C9 – 0%
- C10 – 2%

4.2. The dialog for data input in the application

The data input consists of 4 steps: dimensioning the structures, input of the preliminary data of the problem, evaluating the qualitative criteria and data validation. (Nagy & Miranda, 2012)

Using the dialog in Figure 2, the program receives the following data:

- the number of possible Alternatives for decision
- the total number of criteria considered

- the number of quantitative (numeric) criteria. These have to be introduced first.

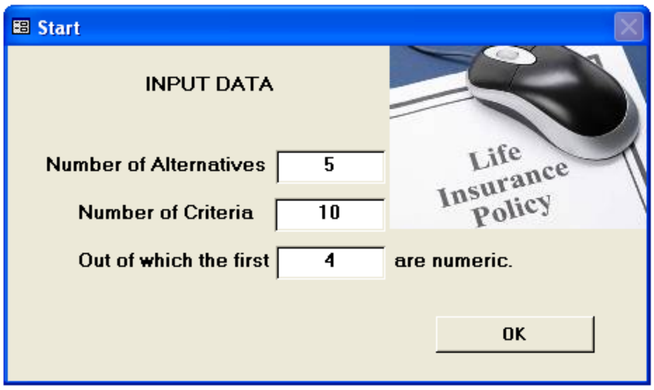

Figure 2 – Dimensioning the model

After introducing the dimension for the problem – thus for the all the matrix involved, the specific data will be typed in the tables (Figure 3).

Specific_Data : Table

Subject	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10
A1	28	0	200	no	no	no	no	yes	no	60
A2	26	0	400	6 hrs	no	yes	no	yes	no	60
A1	35	5	600	12 hrs	yes	yes	world with except	yes	no	80
A4	40	5	600	24 hrs	yes	yes	schengen	yes	yes	no limit
A5	41	10	600	48 hrs	yes	yes	world	yes	yes	no limit

Weights : Table

xx	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10
Importance	0,1	0,05	0,1	0,05	0,1	0,1	0,15	0,1	0,05	0,2
Best if MAX=1 /	0	1	1	1	1	1	1	1	1	1

Figure 3 – Input of the specific data

For the qualitative criteria, a quantitative estimation must be done, using a linear scale between 0 and 1. A similar dialog is used (Figure 4).

Specific_Data_Numeric : Table

Subject	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10
A1	28	0	200	0	0	0	0	1	0	0,33
A2	26	0	400	6	0	1	0	1	0	0,33
A3	35	5	600	24	1	1	0,66	1	1	0,66
A4	40	10	600	12	1	1	0,33	1	0	1
A5	41	10	600	48	1	1	1	1	1	1

Weights : Table

xx	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10
mportance	0,25	0,15	0,1	0,15	0,15	0,08	0,1	0	0	0,02
Best if MAX=1 /	0	1	1	1	1	1	1	1	1	1

Figure 4 – The input matrix, after the numeric evaluation of the qualitative criteria

At this step, data validation consists of verifying the sum of the coefficients – the total of weights must be 1 (Figure5).

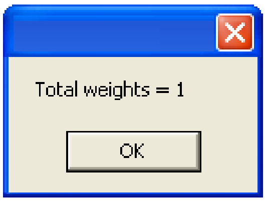

Figure 5 - Message for valid data

4.3. Solving the model

The software application is based on the theoretic considerations presented in the previous chapter. However this works transparently for the user, at request the intermediary steps can be viewed (Figure 6).

Intermediate matrix computed by the program can be visualized as presented in Figure 7. The result matrix is presented in Figure 8 while the result is presented in Figure 9.

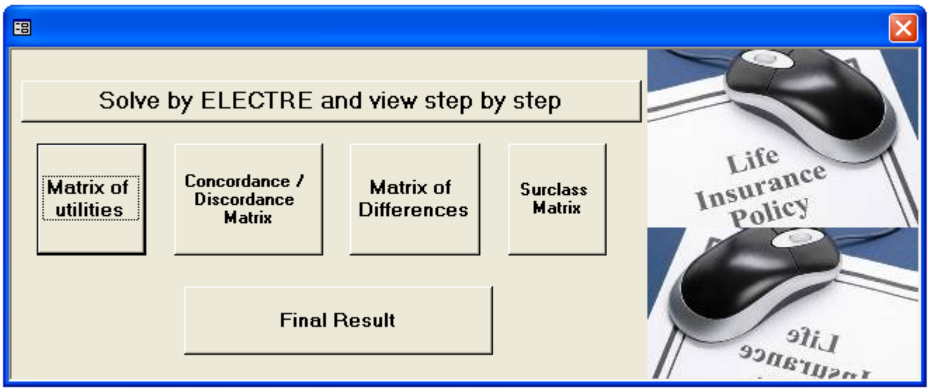

Figure 6 – The step by step menu

tbl_Utilities : Table

Subject	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10
A1	0,8666667	0	0	0	0	0	0	1	0	0,33
A2	1	0	0,5	6	0	1	0	1	0	0,33
A3	0,4	0,5	1	24	1	1	0,66	1	1	0,66
A4	0,06666667	0,5	1	12	1	1	0,33	1	0	1
A5	0	1	1	48	1	1	1	1	1	1

tbl_Concord : Table

Items	A1	A2	A3	A4	A5
A1	0,9999999	0,42	0,25	0,25	0,25
A2	0,9999999	0,9999999	0,33	0,33	0,33
A3	0,75	0,75	0,9999999	0,98	0,58
A4	0,75	0,75	0,5	0,9999999	0,6
A5	0,75	0,75	0,75	0,75	0,9999999

tbl_Discord : Table

Items	A1	A2	A3	A4	A5
A1	0	6	24	12	48
A2	0	0	18	6	42
A3	0,4666667	0,6	0	0,34	24
A4	0,8	0,9333333	12	0	36
A5	0,8666667	1	0,4	0,06666667	0

tbl_Differences : Table

Items	A1	A2	A3	A4	A5
A1	0,9999999	-5,58	-23,75	-11,75	-47,75
A2	0,9999999	0,9999999	-17,67	-5,67	-41,67
A3	0,2833333	0,15	0,9999999	0,64	-23,42
A4	-0,05000001	-0,1833333	-11,5	0,9999999	-35,4
A5	-0,1166667	-0,25	0,35	0,6833333	0,9999999

tbl_Sur : Table

Items	A1	A2	A3	A4	A5	Suma
A1	0	0	0	0	0	0
A2	1	0	0	0	0	1
A3	1	1	0	1	0	3
A4	1	1	0	0	0	2
A5	1	1	1	1	0	4

Figure 7 – Intermediate matrix (step by step view)

tbl_Results : Table

Items	A1	A2	A3	A4	A5	Suma
A1	0	0	0	0	0	0
A2	1	0	0	0	0	1
A4	1	1	0	0	0	2
A3	1	1	0	1	0	3
A5	1	1	1	1	0	4

Figure 8– The matrix of results

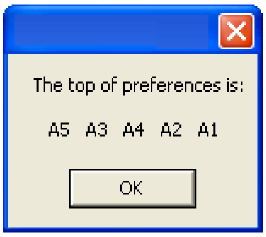

Figure 9 – The result

5. Conclusions, optimization and further developments

The top of preferences for the considered case study is: A5, A3, A4, A2, A1.

The result in Figure 9 is understood like this: a potential "standard" client, chosen for the problem, considering the criteria and the adequate weights, should choose alternative A5 and buy a "Package of flight insurance – extra". The fewest benefits are offered by the product named "International travel insurance".

For this case, optimizing the decision means to reload new data in the application – this facility gives a strong didactic approach too (Miranda & Nagy, 2011). For instance, the client may have different preferences that leads to a different decisional situation. Or, the client may be an older person with higher investment power, giving more importance to the criteria such as maximum age, medical or death insurance. Modifying the weights, the number of criteria or other input data, by repeatedly using the program, the results are for sure different and the client will choose the insurance that best fits his needs.

The paper outlines the importance of using the computer instruments for assisting the decision process and proves the flexibility of the "Electre" application that can be easily adapted to any decisional situation. The program is in a continuous improvement process, being already integrated in a decisional software package, mainly for didactical use within "Aurel Vlaicu" University from Arad.

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