Case study - Using multicriteria analysis methods in project selection

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Abstract

There are several models of multicriteria analysis methods, but there is no common agreement on the most effective method for project selection (Archer & Ghasemzadeh, 2004). In this article, we will present a case study for the selection of projects using two families of multicriteria analysis methods namely the methods of upgrading ELECTRE II and I and utility methods, and then give a comparative summary of the two categories. Through this case study, we note that the results obtained are different depending on the method used and the intended purpose, and the choice between a method close to the Utility Theory (MAUT) and outranking method must be made according to the advantages and limitations of these categories of multicriteria analysis methods (MAM).

Keywords
Multicriteria analysis methods, ELECTRE, MAUT, project selection.

1. Introduction

Current projects evolve in a complex environment that is undergoing rapid and often unpredictable changes. Conventional planning and project execution tools are only effective if they are part of a global project portfolio management approach, while taking into account these dynamic aspects and emphasizing the need to innovate to succeed (Tayeb Louafa, 2008); in project portfolio management, success does not only mean doing projects well, but also choosing the right projects.

In the early phases of project portfolio management, several processes require tools and techniques for project analysis (qualitative and quantitative analysis: prioritization analysis, capacity analysis, graphical analysis, etc.) (PMI, 2013). Thus, multi-criteria decision-making methods become indispensable tools to select the right projects.

There are several models of multicriteria decisions (ELECTRE, PROMETHEE, MAUT, AHP, the weighted sum, etc.) and mathematical optimization (ILP, IGP, etc.). However, there is no common agreement on the most effective method for project selection (Archer & Ghasemzadeh, 2004).

Indeed, selection processes based on quantitative and qualitative criteria are used in decision-making to justify budget investments and resource allocations. In many cases, however, only financial criteria are taken into account in project selection decisions. In other cases, the decision-making process is based on the experience and impression of senior management. And generally the decision that results from these methods can be very debatable (Hugo Caballero et al., 2012).

In this article, we will present a case study for the selection of projects using two families of multicriteria analysis methods namely the methods of upgrading ELECTRE I and II and utility methods, then give a comparative summary of the two categories.

2. The outranking method (ELECTRE I- ELECTRE II)

2.1- Definitions

ELECTRE is a multicriterion decision support method developed in 1968 by Bernard Roy. Bernard Roy helped found the scientific approaches to decision support. On a large number of projects, studies and research, he has been confronted with the limits of single rationality decision models and the difficulties of the decision optimization activity. In doing so, he has contributed to the development of the premises of a three-pillar paradigm: the consideration of multiple criteria for decision support, the preference for reasonable and robust rather than rational solutions and, lastly, a conception of the helping relationship, in decision support, based on the search for a coherence with values rather than the search for optimum (David et al., 2011)

There are six versions of ELECTRE (ELECTRE I, ELECTRE II, ELECTRE III, ELECTRE IS, ELECTRE IV and ELECTRE TRI). The choice of one of these methods of decision support depends on the problem (how the decision problem is posed) and on the types of criteria chosen (true criterion or pseudo criterion).

ELECTRE II: was published in 1971 by Bernard Roy and Patrice Bertier and raises the problem called storage γ. This method aims to rank the alternatives from best to least interesting by defining two additional outranking relationships: a strong relationship that relies on a strong certainty about the hypothesis, and a weak relationship that is based on a low certainty about 'hypothesis.

These relationships are also constructed from the notions of concordance and discordance. The discrepancy and non-discordance tests are nested within each other, with several levels of acceptance.

2.2- Principle of ELECTRE II method

The steps used in the ELECTRE II method are as follows:

- Establish the matrix C of concordance;
- Establish the matrix D of discordance;
- Perform strong and weak outranking tests; introducing three concordance thresholds and two discrepancy thresholds;
- Exploit outranking relationships: direct rankings, reverse rankings and final and median rankings.

Two indices are considered in the construction of the outranking relation aSb:

- Concordance index: measures arguments in favor of the statement "at least as good as b"
- Discrepancy index measures the strength of a (maximal) argument against the overclass relationship "aSb: a is at least as good as b"; it expresses the fact that the decision maker can not accept the preference of a on b if b is much better than a on a criterion (whatever the number of criteria in favor of a on b); this index is therefore all the greater as the preference of **a** over **b** is small on a criterion.

2.3- Case study

2.3-1. Presentation of the case

In order to be able to undertake the most interesting projects, the PMO of ALPHA wants to rank the eight projects in its portfolio of projects, from the most to the least important, taking into account the following five main criteria: budget (cost), profit, human resources used, risk and degree of urgency. It is, therefore, to solve a problem of storage γ with real criteria. For this, we will use the outranking method ELECTRE II. The table below summarizes the data collected from decision-makers:

Data	Project1	Project2	Project3	Project4	Project5	Project6	Project7	Project8
C1= Budget (MAD)	40000	50000	60000	70000	80000	90000	100000	110000
C2=Profit (MAD)	160000	210000	110000	300000	350000	250000	200000	320000
C3=HR used	5	8	7	10	9	8	7	6
C4=Risk weight	3	0	4	4	2	2	1	5
C5=Urgency	2	3	2	2	3	4	1	1

Table 11. Classification data of eight projects on five criteria

2.3-2. Use of ELECTRE I

To facilitate the use of the ELECTRE method, the measurement scales associated with all the criteria must be identical. For this we will rate projects on a scale of 20 for all criteria. We obtain the following matrix with columnar criteria and alternatives (projects) in rows:
The components of the resulting matrix are designated Pij. The weights of the criteria, given by the decision-makers, are given in the last line:

P_{ij}	C1	C2	C3	C4	C5
P1	16	8	15	8	8
P2	15	10,5	12	20	12
P3	14	5,5	13	4	8
P4	13	15	10	4	8
P5	12	17,5	11	12	12
P6	11	12,5	12	12	16
P7	10	10	13	16	4
P8	9	16	14	0	4
Poids	0.2	0.3	0.1	0.1	0.3

Table 2. Ranking data of eight projects on scale 20

<u>The construction of the concordance matrix:</u>
Cij represents the concordance index of the statement "PiSPj: Pi is at least as good as Pj" and is defined as the sum of the normalized weights of the matching criteria:

$$C_{ij} = \frac{\sum_{k \in C} pk}{\sum_{l=1}^{l=n} pl} \quad \left(\sum_{l=1}^{l=n} p_l = 1 \right)$$

with:
- C: all the indices of the matching criteria,
- pk: the weight of the index of the matching criterion,
- n: the number of criteria. (= 5 in this example)

1	0.3	1	0.7	0.3	0.3	0.6	0.7
0.7	1	0.9	0.7	0.7	0.4	0.9	0.6
0.7	0.1	1	0.7	0.3	0.3	0.6	0.6
0.6	0.3	0.7	1	0.2	0.5	0.8	0.6
0.7	0.6	0.7	0.8	1	0.6	0.8	0.9
0.7	0.7	0.7	0.5	0.5	1	0.8	0.6
0.4	0.1	0.5	0.2	0.2	0.2	1	0.6
0.3	0.4	0.4	0.4	0.1	0.4	0.7	1

Table 3. Concordance matrix

<u>The construction of the discordance matrix:</u>
Dij represents the unconformity index to the detriment of the statement "PiSPj: Pi is at least as good as Pj".
Dij is defined as the ratio between the largest difference in evaluation between Pi and Pj on the discordant criteria and the largest difference between the upper and lower echelons of the measurement scale of the alternatives evaluation. Criteria. In our case all the criteria have been recalculated on the same scale which is 20.
The discordance matrix obtained is as follows:

0	0.6	0	0.35	0.425	0.4	0.4	0.4
0.15	0	0.5	0.225	0.35	0.2	0.05	0.225
0.2	0.8	0	0.425	0.6	0.4	0.6	0.525
0.25	0.8	0.15	0	0.4	0.4	0.6	0.2
0.2	0.4	0.1	0.05	0	0.2	0.2	0.15
0.25	0.4	0.15	0.125	0.25	0	0.2	0.175

0.3	0.4	0.2	0.25	0.4	0.6	0	0.3
0.4	1	0.25	0.2	0.6	0.6	0.8	0

Table 4. Discordance matrix

Consider the two thresholds of agreement and discordance, Sc and Sd, such as: $0 \le Sd \le 1$ and $0 \le Sc \le 1$
Posons: Sc = 0.9 and Sd = 0.15 and determine the Cij and Dij such that: $Cij \geq Sc$ and $Dij \le Sd$
The result is mentioned on the following two matrices of concordance and discordance:

	P1	P2	P3	P4	P5	P6	P7	P8
P1	1	0.3	1	0.7	0.3	0.3	0.6	0.7
P2	0.7	1	0.9	0.7	0.7	0.4	0.9	0.6
P3	0.7	0.1	1	0.7	0.3	0.3	0.6	0.6
P4	0.6	0.3	0.7	1	0.2	0.5	0.8	0.6
P5	0.7	0.6	0.7	0.8	1	0.6	0.8	0.9
P6	0.7	0.7	0.7	0.5	0.5	1	0.8	0.6
P7	0.4	0.1	0.5	0.2	0.2	0.2	1	0.6
P8	0.3	0.4	0.4	0.4	0.1	0.4	0.7	1

	P1	P2	P3	P4	P5	P6	P7	P8
P1	0	0.6	0	0.35	0.425	0.4	0.4	0.4
P2	0.15	0	0.5	0.225	0.35	0.2	0.05	0.225
P3	0.2	0.8	0	0.425	0.6	0.4	0.6	0.525
P4	0.25	0.8	0.15	0	0.4	0.4	0.6	0.2
P5	0.2	0.4	0.1	0.05	0	0.2	0.2	0.15
P6	0.25	0.4	0.15	0.125	0.25	0	0.2	0.175
P7	0.3	0.4	0.2	0.25	0.4	0.6	0	0.3
P8	0.4	1	0.25	0.2	0.6	0.6	0.8	0

Table 5. Concordance and discordance matrices (S_c= 0.9 et S_d=0,15)

The condition $Cij \geq Sc$ must be satisfied before checking if $Dij \leq Sd$.

P1→P3	et	P1 → P3
P2→P3		
P2→P7	et	P2 → P7
P5→P8	et	P5 → P8

The nucleus obtained consists of 5 nodes: P1, P2, P4, P5 and P6.
We obtain 2 levels of classification, called "equivalence classes":

- Level1: P1, P2, P4, P5 and P6.
- Level2: P3, P7 and P8.

We thus obtain the best projects selected by the method ELECTRE I. but to refine the classification, we will use the method ELECTRE II.

2.3-3. Use of ELECTRE II

To apply the method ELECTRE II, we will introduce two thresholds of (S_{cF} and S_{cf} with $Sc_F > Sc_f$) relating to the high and low outranking (S^F and S^f) The two strong and weak outranking relationships (SF and Sf) are defined by:

$$P_i\, S^F P_j \Leftrightarrow \begin{cases} C_{ij} \geq Sc_F \\ D_{ij} \leq S_d \\ \sum_{k/\,Pik>Pjk} w_k > \sum_{k/\,Pik<Pjk} w_k \end{cases}$$

$$P_i\, S^f P_j \Leftrightarrow \begin{cases} C_{ij} \geq Sc_f \\ D_{ij} \leq S_d \\ \sum_{k/\,Pik>Pjk} w_k > \sum_{k/\,Pik<Pjk} w_k \end{cases}$$

We take Sc_f=0.8,

P1 P2 P3 P4 P5 P6 P7 P8 P1 P2 P3 P4 P5 P6 P7 P8

1	0.3	1	0.7	0.3	0.3	0.6	0.7	P1	0	0.6	0	0.35	0.425	0.4	0.4	0.4
0.7	1	0.9	0.7	0.7	0.4	0.9	0.6	P2	0.15	0	0.5	0.225	0.35	0.2	0.05	0.225
0.7	0.1	1	0.7	0.3	0.3	0.6	0.6	P3	0.2	0.8	0	0.425	0.6	0.4	0.6	0.525
0.6	0.3	0.7	1	0.2	0.5	0.8	0.6	P4	0.25	0.8	0.15	0	0.4	0.4	0.6	0.2
0.7	0.6	0.7	0.8	1	0.6	0.8	0.9	P5	0.2	0.4	0.1	0.05	0	0.2	0.2	0.15
0.7	0.7	0.7	0.5	0.5	1	0.8	0.6	P6	0.25	0.4	0.15	0.125	0.25	0	0.2	0.175
0.4	0.1	0.5	0.2	0.2	0.2	1	0.6	P7	0.3	0.4	0.2	0.25	0.4	0.6	0	0.3
0.3	0.4	0.4	0.4	0.1	0.4	0.7	1	P8	0.4	1	0.25	0.2	0.6	0.6	0.8	0

Table 6. Concordance and discordance matrices (Scf= 0.8 et S_d=0,15)

We obtain :

P1→P3 et P1 → P3=> $P_1\ S^F\ P_3$
P2→P3
P2→P7 et P2 →P7 => $P_2\ S^F\ P_7$
P4→P7
P5→P4 et P5→ P4 => $P_5\ S^f\ P_4$
P5→P7
P5→P8 et P5 → P8=> $P_5\ S^F\ P_8$
P6→P7

This leads to an additional level:

- Level1: P1, P2, P5 and P6.
- Level2: P4,
- Level3: P3, P7 and P8.

The following condition: $\sum_{k\,/\,Pik>Pjk} w\text{k} > \sum_{k\,/\,Pik<Pjk} w\text{k}$ is satisfied for all overclassing relations on the matrix Pij.

Projects at the same level are difficult to compare. They belong to the same equivalence class. The Electre II method provides a clearer idea of the relative importance of projects by arranging projects from Level1 to Level3 (Level1 represents the most important projects).

3. Use of utility methods (MAUT):

3.1 Definition

MAUT is an acronym for (Multi Attribute Utility Theory), is a utility-based method developed by Keeney and Raiffa in 1976. It is closer to substantial rationality. This approach, born in the late 1960s, is directly inspired by work on the utility of Von Neumann and Morgenstern. The central idea is very simple: the decision maker is supposed to associate a utility with each of the actions in question, considering separately each of the criteria and observing which utility releases each criterion for the action in question.

3.2 Principle of utility methods

In MAUT utility methods there are three steps:

- Define the utility function: get a score on each criterion.
- Use an aggregation function: Aggregate the criteria into a synthesis criterion for each alternative.
- Compare the synthesis criteria.

MAUT aims to numerically represent the preferences of the decision-maker, expressed in the form of a total pre-order, by a function u: X → IR generally called "utility function" such as:

$\forall x, y \in X,\ x \succsim y \Leftrightarrow u(x) \geq u(y)$

The function u is constructed in such a way that the higher the overall utility associated with an alternative, the more this solution is "preferred" by the decision-maker.In general, one poses: $u = F \circ U$ such that:

- $U(x) = (u_1(x_1), \ldots, u_n(x_n))$,
- $u_i : X_i \rightarrow IR$ is a utility function on i,
- $F : IR^n \rightarrow IR$ is an aggregation function,

Taking into account the previously defined assumptions, the global utility function can be defined as follows:

$$\begin{cases} \forall x, y \in X,\ x \succsim y \Leftrightarrow u(x) \geq u(y) \\ \forall (x_1, \ldots, x_n) \in X,\ u(x_1, \ldots, x_n) := F(U(x_1, \ldots, x_n)) \end{cases}$$

3.3 Case study

The PMO of the company will use, this time, aggregation functions to select the most interesting projects according to criteria C1, C2, C3, C4 and C5.
If we consider the following definitions:

- N = {1,. . . , n} is the set of n criteria.
- X is the set of alternatives or options.
- X 'is a subset of X.
- (X1, ..., Xn) is the set of attributes.
- X = (x1, ..., xn) is an alternative defined in the set X = X1 × · · · × Xn.

We can redefine the problem data as follows:
$X_1 = [0; 200\,000]$; $X_2 = [0; 400\,000]$; $X_3 = [0; 20]$; $X_4 = [0; 5]$; $X_5 = [0; 5]$;
X is the set of projects {P1, ..., P8};

We will see some aggregation functions through this example. The application of an aggregation function requires the commensurability of the different criteria that is obtained thanks to the utility functions ui. If we apply the utility functions on the previous example, we obtain the following table:

Data	**Project1**	**Project2**	**Project3**	**Project4**	**Project5**	**Project6**	**Project7**	**Project8**
C1	16	15	14	13	12	11	10	9
C2	8	10,5	5,5	15	17,5	12,5	10	16
C3	15	12	13	10	11	12	13	14
C4	8	20	4	4	12	12	16	0
C5	8	12	8	8	12	16	4	4

Table 7. Applying utility functions to project data

3.3.1- Pareto dominance:

The Pareto dominance method was published in 1906. It is defined as follows:

$$x \succsim y \Leftrightarrow \forall\, i \in N,\ u_i(x) \geq u_i(y)$$

Example: Posing P1 = Project1 and P3 = Project3.
We have $\forall\, i \in \{1,..,5\}$, $u_i(P1) \geq u_i(P3)$ so the project P1 is preferred according to the Pareto dominance of the project P3.

Result : P1 $\succsim$ P3.

3.3.2- Lorenz dominance :

The Lorenz dominance method was published in 1905. It is defined as follows:

$$x \succsim y \Leftrightarrow \forall\, i \in N,\ \sum_{\substack{i \in N \\ j \leq i}} u_j(Tx_j) \geq \sum_{\substack{i \in N \\ j \leq i}} u_j(Ty_j) \text{ avec } u_i(Tx_i) \leq u_i(Tx_{i+1})$$

T, being a definite permutation of IR → IR.
Example: considering the two projects P1 = (16, 8, 15, 8, 8) and P2 = (15, 10.5, 12, 20, 12). Which amounts to comparing (8, 8, 8, 15, 16) with (10.5, 20, 12, 12, 15)

Result : P2 $\succsim$ P1.

3.3.3- Operators min, max, median,

The operator aggregation functions are defined by the following relationships:

$$x \succsim y \Leftrightarrow \forall\, i \in N,\ \min(u_i(x)) \geq \min(u_i(y))$$

$$x \succsim y \Leftrightarrow \forall\, i \in N,\ \max(u_i(x)) \geq \max(u_i(y))$$

$x \gtrsim y \Leftrightarrow \forall i \in N$, med $(u_i(x)) \geq$ med$(u_i(y))$

Example: considering the two projects P1 = (16, 8, 15, 8, 8) and P4 = (13, 15, 10, 4, 8). Applying the three operators min, median and max:

P1 $\gtrsim_{min}$ P4

P1 $\lesssim_{med}$ P4

P1 $\gtrsim_{max}$ P4

3.3.4- Simple additive function :

The additive function **F** : $IR^n \rightarrow IR$ is defined by the sum of the utilities u_i as follows:

$$\begin{cases} \forall(x_1, \ldots, x_n) \in X, u(x_1, \ldots, x_n) = \sum_{i \in N} u_i(x_i) \\ x \gtrsim y \Leftrightarrow \forall i \in N, \sum_{i \in N} u_i(x_i) \geq \sum_{i \in N} u_i(y_i) \end{cases}$$

Example: The same data presented in Table 8 is considered. By applying the additive aggregation function, we obtain the following result:

ui(xi)	P1	P2	P3	P4	P5	P6	P7	P8
C1	16	15	14	13	12	11	10	9
C2	8	10,5	5,5	15	17,5	12,5	10	16
C3	15	12	13	10	11	12	13	14
C4	8	20	4	4	12	12	16	0
C5	8	12	8	8	12	16	4	4
Total	55	69,5	44,5	50	64,5	63,5	53	43

Table 8. Application of the additive aggregation function on project data

Result : P8 $\lesssim$ P3 $\lesssim$ P4 $\lesssim$ P7 $\lesssim$ P1 $\lesssim$ P6 $\lesssim$ P5 $\lesssim$ P2

3.3.5- Weighted sum

The weighted sum is a special case of simple additive aggregation where the weights are equivalent. It is defined by the following relation:

$$\begin{cases} \forall(x_1, \ldots, x_n) \in X, u(x_1, \ldots, x_n) = \sum_{i \in N} w_i\, u_i(x_i). \\ x \gtrsim y \Leftrightarrow \forall i \in N, \sum_{i \in N} w_i u_i(x_i) \geq \sum_{i \in N} w_i u_i(y_i) \end{cases}$$

Such that: w_i is the weight associated with criterion i defined in [0,1], and $u_i : X_i \rightarrow IR$ is the utility function associated with criterion i.

Example: Considering the same projects in Table 1, and the following set of weights: (0.2, 0.3, 0.1, 0.1, 0.3).

ui(xi)	P1	P2	P3	P4	P5	P6	P7	P8	**weight**
C1= Budget	16	15	14	13	12	11	10	9	**0,2**
C2=Profit	8	10,5	5,5	15	17,5	12,5	10	16	**0,3**
C3=HR used	15	12	13	10	11	12	13	14	**0,1**
C4=Risque weight	8	20	4	4	12	12	16	0	**0,1**
C5=Urgency	8	12	8	8	12	16	4	4	**0,3**
total_weight	10,3	12,95	8,55	10,9	13,55	13,15	9,1	9,2	

Table 9. Weighted Sum Application on Project Data

Result : P3 $\lesssim$ P7 $\lesssim$ P8 $\lesssim$ P1 $\lesssim$ P4 $\lesssim$ P2 $\lesssim$ P6 $\lesssim$ P5

3.3.6- OWA (Ordered Weight Average)

OWA is the weighted sum of utilities; it is a special case of the weighted sum. It is defined as follows:

$$\begin{cases} \forall(x_1, \ldots, x_n) \in X, u(x_1, \ldots, x_n) = \sum_{i \in N} wi\, u_i(x_i). \\ x \gtrsim y \Leftrightarrow \forall i \in N, u_i(x) \geq u_i(y) \quad \text{avec } u_i(x_i) \leq u_i(x_{i+1}) \end{cases}$$

Example: Applying the same set of weights, from the previous example, on the sorted attributes of projects we find:

P1	P2	P3	P4	P5	P6	P7	P8	Weight
8	10,5	4	4	11	11	4	0	**0,2**
8	12	5,5	8	12	12	10	4	**0,3**
8	12	8	10	12	12	10	9	**0,1**
15	15	13	13	12	12,5	13	14	**0,1**
16	20	14	15	17,5	16	16	16	**0,3**
11,1	14,4	8,75	10	13,45	13,05	10,9	8,3	

Table 10. Weighted Sum Application on Project Data

Result : P8 $\precsim$ P3 $\precsim$P4 $\precsim$P7 $\precsim$ P1 $\precsim$P6 $\precsim$P5 $\precsim$ P2

In the particular case, where the weight set is equal to (1, 0, 0, 0, 0), the OWA function corresponds to the min operator.

In the particular case, where the weight set is equal to (0, 0, 0, 0, 1), the OWA function corresponds to the max operator.

3.3.7- Choquet integral

The Choquet integral is an aggregation function applying a non-additive model contrary to the previous functions. It is defined by the following relation:

$$\begin{cases} \forall(x_1, \ldots, x_n) \in X, C(x)= u(x_1, \ldots, x_n) = \sum_{i \in N} w_{\{i,\ldots,n\}}(u_i(x_{T(i)}) - u_i(x_{T(i-1)})). \\ x \succsim y \Leftrightarrow \forall\, i \in N, u_i(x) \geq u_i(y) \\ \text{avec } T(i) \text{ une permutation telle que } u_i(x_{T(i)}) \leq u_i(x_{T(i+1)}) \text{ et } u_1(x_{T(0)}) = 0. \end{cases}$$

<u>Example:</u> considering the following data:

- The subset consisting of four projects: P1, P4, P7, P8;
- The criteria: C1, C2, C3, C4 and C5;
- And the following weight set:

{0}= Ø
{1} = 0.2, {2} = 0.3, {3} = 0.1, {4} = 0.1, {5} = 0.3,
{1,2} = 0.5, {1,3}= 0.3, {1,4}= 0.3, {1,5}= 0.5,
{2,3}= 0.4, {2,4}= 0.4, {2,5}=0.6,
{3,4}= 0.2, {3,5} = 0.4,
{4,5}= 0.4,
{1, 2, 3}= 0.6, {1, 2, 4}= 0.6, {1, 2, 5}= 0.8,
{1, 3, 4}= 0.4, {1, 3, 5}= 0.6,
{1, 4, 5}= 0.6,
{2, 3, 4}= 0.5, {2, 3, 5}= 0.7,
{2, 4, 5}= 0.6,
{3, 4, 5}= 0.5,
{1, 2, 3, 4}= 0.7, {1, 2, 3, 5}= 0.9,
{1, 2, 3, 4, 5} = 1.

$C(P1)= C(16, 8, 15, 8, 8)= 8+w_{\{1, 3\}}(15-8) + w_{\{1\}}(16-15) = 10.3$

$C(P4) = C(13, 15, 10, 4, 8) = 4 + w_{\{1, 2, 3, 5\}}(8-4) + w_{\{1, 2, 3\}}(10-8)+ w_{\{1, 2\}}(13-10) + w_{\{2\}}(15-13) = 10.9$

$C(P7) = C(10, 10, 13, 16, 4) = 4 + w_{\{1, 2, 3, 4\}}(10-4) + w_{\{3, 4\}}(13-10) + w_{\{4\}}(16-13) = 4 + 0.7*6 + 0.2*3 + 0.1*3 = 9.1$

$C(P8) = C(9, 16, 14, 0, 4) = w_{\{1, 2, 3, 5\}}4+ w_{\{1, 2, 3\}}(9 -4) + w_{\{2, 3\}}(14-9)+ w_{\{2\}}(16-14) = 0.9*4+ 0.6*5+0.4*5+0.3*2 = 9.2$

Result : P7 $\precsim$ P8 $\precsim$P1 $\precsim$P4

3.3.8- Conclusion on MAUT methods

We note that the results obtained are different depending on the method used and the intended purpose. Although the MAUT approach highlights a wide variety of easily comparable numerical solutions and uses fairly simple computational methods, it is still complex for the decision-maker to visualize what utility is associated with. performance given on each criterion and give a total pre-order. In addition, it is a totally compensatory method, that is to say that the bad score of an action on a criterion can be completely compensated by its good score on another criterion which complicates the interpretation results obtained.

4. Comparative of the two categories

The table below summarizes the advantages and limitations of each type of these methods.

MAM Categorie	Advantages	Limitations
Outranking method	- A more elaborate structure based on a reflexive relationship, - it inform the decision-maker about his choice; the actions to be eliminated and those to be kept (but incomparable between them), - Most outranking methods construct the overclass relationship based on two concepts of concordance and non-discordance.	- structure preferably developed progressively on the basis of less rich information (absence of pre-orders), - acceptance of the idea of the incomparability of actions, which often leads to a more in-depth study with the aim of reducing or clarifying all the actions and all the criteria, - Does not solve the problem of decision-making, - The outranking relationship has no particular properties other than reflexivity. As a result, outranking methods will first have to build this relationship and then use it to answer the chosen problem.
Utility Theory	- Production of a total pre-order, - The result is very rich, based on the wealth of hypotheses of the theory, - Produce a function that can store all the actions from the best to the least good: Large varieties of solutions put forward according to the method used, - Possibility to have the decision-maker describe this function via a set of numerous and sometimes-difficult questions concerning the intensities of his preferences and the weightings of the criteria and / or the substitution rates between criteria.	- Need a lot of information (values and parameters) -Additional methods: compensatory. -Delicate interpretation of the parameters, -A sensitivity analysis should be conducted systematically, to release the only robust information, but this is rarely done.

Table 11. Advantages and limitations of outranking method and utility theory

5. Conclusion:

All multi-criteria decision support methods have the advantage of being able to make a decision based on multiple criteria and not on the basis of a single criterion (profit for example). Beyond this observation, the results obtained are different from one method to another.

Thus, the choice between Utility Theory (MAUT) and outranking method must be done according to the advantages and limitations of these broad categories of multicriteria analysis methods (MAM). Indeed, MAUT has the advantage of being easier to use but its compensatory character makes the interpretation of the results difficult. Unlike the ELECTRE method, which is more difficult to apply, but it helps to inform the decision-maker about his choice between the actions or projects to be kept and those to be eliminated but doesn't solve the problem of decision-making itself.

This is why the use of other methods is still necessary to complete the decision-making process. For example, the AHP (Analytic hierarchy process) which allows to hierarchically structure a complex, multi-criteria, multi-person and multi-period problem. This method is used for decision making in complex situations where human perception, judgments, and consequences have long-term implications (Bhushan and Rai, 2004). Thus, the combination of several methods remains possible.

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Biographies

Houda Tahri is an IT engineer from Mohammadia School of Engineers (EMI) with a long experience in IT project management. She held the position of Head of IT department at ISCAE (the Higher Institute of Commerce and Business Administration) where she participated in the QMS certification workshops, awareness and training of ISCAE staff. Later, she held the position of Head of Engineering Department at ONEE (National Electricity and Water Company) where she developed a rich experience in project management with different types of stakeholders. She has maintained her skills through advanced training, active and renewed PMP certification (PMP #1315392), and doctoral studies in project management. As a PhD candidate at IMOSYS Research team (Engineering, management and optimization of systems) at EMI (Mohammadia School of Engineers), she has presented and published several research papers, in Morocco and internationally. Its areas of research mainly concern IT Project Management, Project Management Maturity, Mathematical optimization methods in project portfolio management, Design of an integrated system for project management, project management maturity of Moroccan organizations and the last one with IEOM in 2017 "The new Project Management Maturity Mixed Model (P4M) and the OPM3: Case of a PMO implementation".