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Theory and Methodology

The Conflict Analysis Method: bridging the gap between ELECTRE, PROMETHEE and ORESTE

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Abstract: In this article a multicriteria method, called the Conflict Analysis Model, is developed combining the preference function approach of ELECTRE and PROMETHEE with the conflict analysis test of ORESTE. The result is a comprehensive framework for multicriteria decision making that can be applied to all kind of problems no matter whether the data are ordinal or cardinal. After a description of the methodology, the method is applied to an investment choice problem in agriculture.

Keywords: Decision making; Multicriteria analysis; Preference function; Conflict analysis

1. Introduction

Since the introduction of the outranking concept by the first ELECTRE method in the mid sixties (Benayoun, Roy and Sussman, 1966; Roy, 1968), a lot of aggregation methods for discrete multicriteria problems have been developed, based on this principle. Besides the extension of the ELECTRE I concept (Roy, 1968) by i.a. Roy and Bertier (1971, 1973), Roy (1973, 1977, 1978), Roy and Hugonnard (1982) and Skalka (1984) and numerous applications of this method, two of the most interesting approaches are the PROMETHEE and ORESTE method.

PROMETHEE, described by Brans and Vincke (1985) but further developed and applied by i.a. Mareschal (1986, 1988), Mareschal and Brans (1988, 1991), D'Avignon and Mareschal (1989), Dubois et al. (1989) and Mladineo et al. (1987), extends the notion of preference function, allowing other types of preference functions to be used than the true, quasi and pseudo criterion of the ELECTRE approach.

The ORESTE method, first introduced by Roubens (1982) but more elaborated and further extended by Pastijn and Leysen (1989) and Lillich (1990), makes only use of rank order information. However, the most interesting part of the method is the conflict analysis test making it possible to separate indifference, incomparability and preference situations.

Because all three methods have interesting features, a model is presented trying to combine these features. The method is called the Conflict Analysis Model or CAM and is based on a more general formulation of the pairwise comparison principle. It combines from ELECTRE the basic notions of

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indifference, incomparability, weak and strong preference, from PROMETHEE the different types of preference functions and from ORESTE the PIR-test. This makes of CAM a comprehensive framework for multicriteria analysis that can be applied to all kind of problems, no matter what kind of data are available.

After a description of the methodology, the method is illustrated with a typical investment problem in agriculture: the purchase of a tractor.

2. The CAM-method

2.1. Preference indicators

Typical for what Vincke (1986) and Colson and De Bruyn (1989) are calling the French school of multicriteria decision making, is the outranking concept. This means that an outranking relation is build up under the form of pairwise comparison of the objects under study. The aim is to determine on the basis of all relevant information for each pair of objects if there exists preference, indifference or incomparability. For this purpose preference or dominance indicators are defined and compared with certain threshold values. This in contrast with the American Multi Attribute Utility Theory (MAUT) approach which is based on the formulation of an overall utility function (Keeney and Raiffa, 1976).

Strong preference will only be concluded if there exists enough evidence that one of the objects is clearly dominating the object it is compared with, while weak preference expresses a certain lack of conviction. Indifference means that both objects are equivalent and that it does not matter which of both is selected. This in contrast with the concept of incomparability that indicates objects with strong opposite merits.

The preference indicator used in CAM is defined as follows:

Let $e_j(a)$ and $e_j(b)$ being the evaluation scores to be maximised for criterion j of respectively object a and b:

$$P(a,b) = (1/n) \sum_{j=1}^{n} g_j \cdot \hat{e}_j(a,b) \tag{1}$$

with:

$$\hat{e}_j(a,b) = \begin{cases} f\{e_j(a) - e_j(b)\} & \text{if } e_j(a) > e_j(b), \\ 0 & \text{if } e_j(a) \le e_j(b). \end{cases}$$

g_j = Factor expressing the relative importance of criterion j.

n = Total number of criteria.

As can be derived from this formula, the degree of dominance $P(a,b)$ is both function of the difference in evaluation score and of the relative importance of those criteria for which a is judged to be better than b.

The preference score for a criterion can be measured along a preference curve, transforming the difference in evaluation scores into a preference score between 0 and 1. As in PROMETHEE different types of preference functions can be used depending on the nature of the data. Because they are somewhat different from the one used in PROMETHEE they are represented as type A to F. They are represented in Figure 1.

Type A is the true criterion function applied in the ELECTRE I approach or the usual criteria in PROMETHEE, which is characterized by an infinite discriminating power. Any difference in score implies immediatly a total preference or in other words the preference indicator $P(a,b)$ will only depend upon the sum of weights of those criteria for which a is better than b. The same holds for the second type of preference function, the quasi criterion or U-shaped criterion, but here an indifference threshold q, allowing a margin of error in the evaluation scores, is considered.

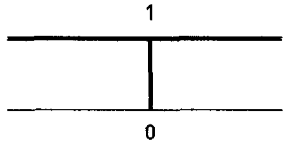
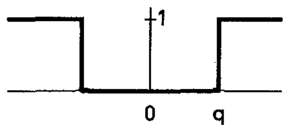
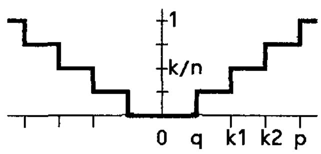
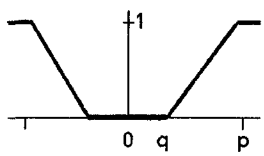
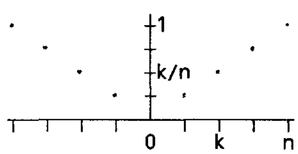
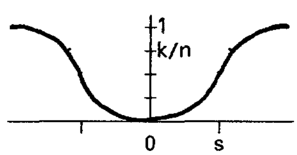
Criterion type	Preference function	Parameters to be defined
Type A : 0-1 criterion $\hat{e}(a,b) = \begin{cases} 0 \text{ if } \lvert e(a)-e(b)\rvert = 0 \\ 1 \text{ if } \lvert e(a)-e(b)\rvert > 0 \end{cases}$		
Type B : 0-1 criterion with indifference area $\hat{e}(a,b) = \begin{cases} 0 \text{ if } \lvert e(a)-e(b)\rvert \le q \\ 1 \text{ if } \lvert e(a)-e(b)\rvert > q \end{cases}$		- indifference threshold q
Type C : Multilevel criterion $\hat{e}(a,b) = \begin{cases} 0 & \text{if } \lvert e(a)-e(b)\rvert \le q \\ k/n & \text{if } k1 < \lvert e(a)-e(b)\rvert \le k2 \\ 1 & \text{if } \lvert e(a)-e(b)\rvert > p \end{cases}$		- indifference threshold q - interval thresholds k - preference threshold p
Type D : Linear criterion $\hat{e}(a,b) = \begin{cases} 0 & \text{if } \lvert e(a)-e(b)\rvert \le q \\ \frac{\lvert e(a)-e(b)\rvert}{p} & \text{if } q < \lvert e(a)-e(b)\rvert \le p \\ 1 & \text{if } \lvert e(a)-e(b)\rvert > p \end{cases}$		- indifference threshold q - preference threshold p
Type E : Rank order criterion $\hat{e}(a,b) = \begin{cases} 0 & \text{if } \lvert e(a)-e(b)\rvert = 0 \\ k/n & \text{if } \lvert e(a)-e(b)\rvert = k \\ 1 & \text{if } \lvert e(a)-e(b)\rvert = n \end{cases}$		
Type F : Gaussian criterion $\hat{e}(a,b) = 1 - e^{-[\lvert e(a)-e(b)\rvert^2/2s^2]}$		- flexure point s

Figure 1. Criteria and their preference function

The third type (the multi-level criterion) is an extension of what Roy (1985) is calling a pseudo criterion. The level of dominance depends on the interval in which the difference in evaluation scores is situated. This kind of preference function is e.g. used in the AHP method of Saaty (1988). It allows to consider information measured on a semantic or interval scale. The step between the ranges can be equal or not. If only two levels are considered this type is equal to the level criterion in PROMETHEE.

Type D is probably the most common type of preference function and the one applied in the weighted summation technique. It will be used if the preference intensity changes straight on with the difference in evaluation scores. The slope of the preference function will depend on the value of the total preference threshold p (cf. the different standardisation procedures of the weighted summation). In PROMETHEE this is called the V-shaped criterion (if $q = 0$) or the V-shaped criterion with indifference threshold.

The rank order criterion (type E) is a discontinuous type of preference function that only makes use of the ranking of the objects for each criterion (cf. ORESTE). In CAM, the difference in rank order is divided by the maximum difference observed. This does not mean any violation of the ordinal information, but allows the combination with other types of criteria.

In the Gaussian type of preference function (type F), the preference score changes continuously with the difference in evaluation score. This function is asymptotic (meaning that absolute preference can not be reached) and will be selected if above a certain level an increase in the difference in evaluation scores is regarded to be less important.

Normally these six types of preference functions have to be sufficient, whatever the nature of the data, to transform all kind of criteria into a preference score between 0 and 1. However, nothing prevents the addition of other types of preference functions, if necessary.

2.2. *Determination of the weights*

Once for all criteria, the preference scores $\hat{e}_j(a,b)$ have been calculated, they have to be weighted according to their relative importance. In CAM, the information about the hierarchy of the criteria can be introduced and obtained in three ways:

(a) The decision maker is able to give quantitative weights: these weights are rescaled between 0 and 100 and introduced in formula (1).

(b) The decision maker is only able to give a rank order: in that case the expected value of the weights is calculated as explained in the next paragraph.

(c) The decision maker is not able to give a priority order: in this case he is asked to compare the criteria two by two and the weights are derived from the eigenvector of the pairwise comparison matrix. Two scales are possible: a three point scale ('$<$', '$=$' or '$>$') or a nine point scale (as in the AHP method of Saaty).

If only a complete or incomplete rank order is available (case (b)), theoretically two approaches are possible. The first approach is applied in the ORESTE method where the rank order information of the priorities is combined with the information about the criterion scores in a distance function but in our opinion in a rather complicated and arbitrary way. A theoretical more sound basis is to estimate the expected average value of the g_j-factor (Van Huylenbroeck, 1990, 1992).

It can be proved (Rietveld, 1984, 1989) that if a uniform distribution is assumed, the expected values of the weights fullfilling the conditions imposed by the ordinal rank order are given by

$$g_j = \sum_{i=k}^{n} (1/i) \tag{2}$$

with k = the priority level or ranking of criterion j (with $k = 1$ for the most important and $k = n$ for the least important criterion)

Modifications to this formula make it also possible to handle rank orders with ties (by multiplying the weight factor of order k by the number of times this rank order occurs) or with a degree of difference. A degree of difference means that the decision maker is able to give an indication about the distance between the rankings, e.g. that the distance between C1 and C2 is three times the distance between C2 and C3. Hirsch (1976) speaks in this respect about ordinal metric information. This information can be used by introducing artificial or auxiliary criteria (equal score for all objects). For more information we refer to Rietveld and Ouwersloot (1992).

The sensitivity of the expected value estimation can be explored by a sensitivity test generating a random sample of weights meeting the ordinal conditions (see Section 3.2).

2.3. Conflict analysis

The preference indicator $P(a,b)$ defined above is measuring the degree of dominance of a over b. Based on the same definition, the preference indicator $P(b,a)$ will give an indication about the degree of dominance of object b over a. Comparison of both indicators will make it possible to analyse the degree of conflict between both objects. As already indicated, the PIR test of the ORESTE method looks very attractive. Therefore in CAM, this test has been generalized and extended as represented in Figure 2.

Pastijn and Leysen (1989) indicate that the threshold values used in this conflict test can be selected freely but can be related to certain reference situations as well. The indifference threshold β, e.g. can be considered as a kind of allowed margin of error in the determination of the preference scores. For this threshold a lower and upper bound can be defined. The upper bound can be derived from the conditions for a Pareto situation of perfect dominance:

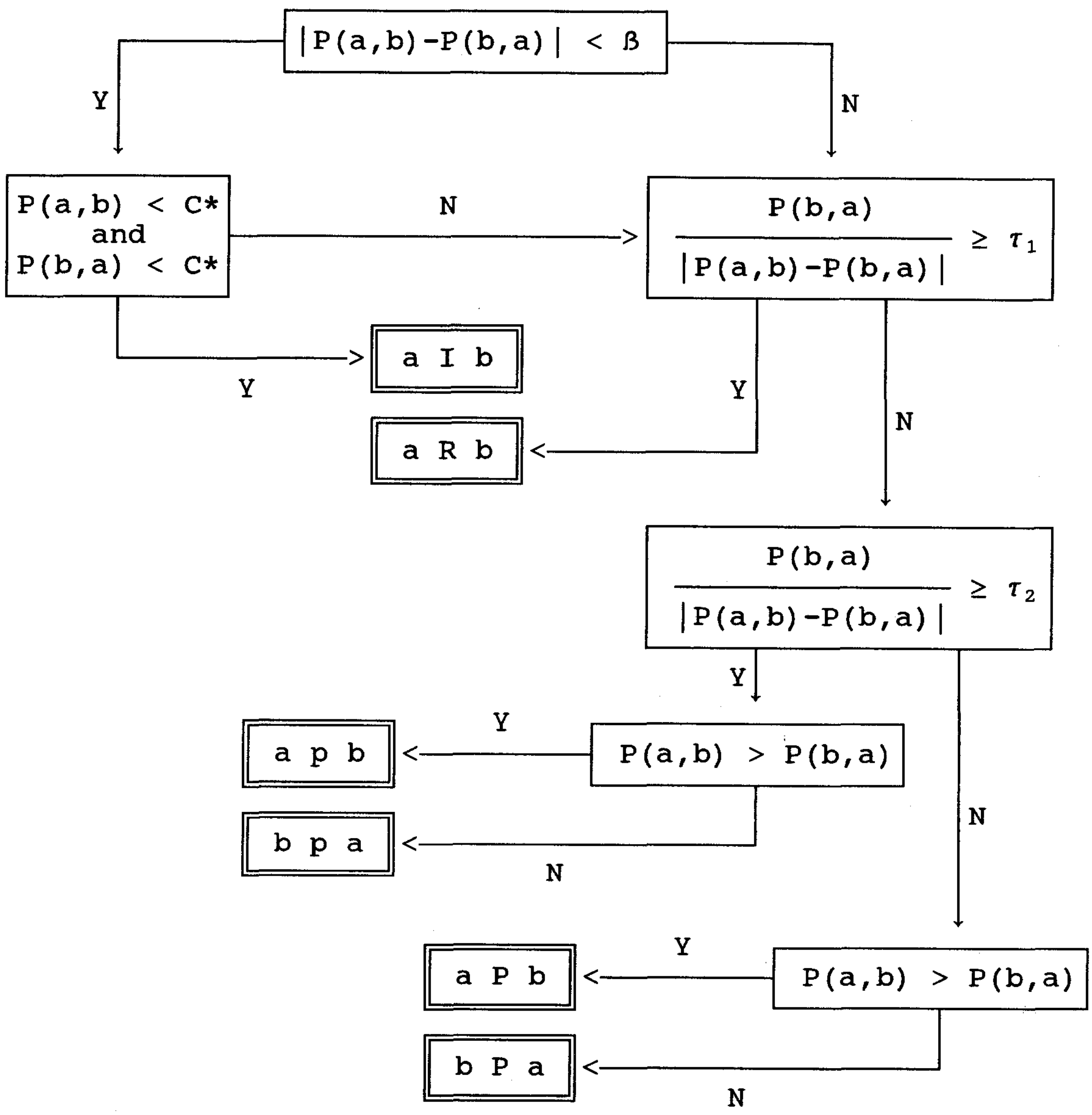


Figure 2. PIR sensitivity test (I = indifference, R = incomparability, p = weak preference and P = strong preference)

Assume that for each criterion j an indifference threshold β_j is specified so that:

$$a >_j b \Leftrightarrow e_j(a) - e_j(b) > \beta_j \Leftrightarrow \hat{e}_j(a,b) > f(\beta_j).$$

If there has to be unanimity for all criteria, this means:

$$|P(a,b) - P(b,a)| = \frac{1}{n} \sum_{j=1}^{n} g_j \cdot f(\beta_j) - 0 > \beta \Leftrightarrow \beta < \frac{1}{n} \sum_{j=1}^{n} g_j \cdot f(\beta_j).$$

However, for simple dominance it is enough that both objects are equal for all criteria except one (Lillich, 1990), or

$$a \approx_k b \text{ for } k <> j \text{ and } a >_j b \Rightarrow a\, P\, b,$$

or

$$\hat{e}_k(a,b) = 0 \text{ and } \hat{e}_j(a,b) > f(\beta_j) \Rightarrow a\, P\, b,$$

or

$$|P(a,b) - P(b,a)| = (1/n) g_j \cdot f(\beta_j) - 0 > \beta \Rightarrow a\, P\, b.$$

As this is a minimum condition and j can be selected arbitraly, it is sufficient that

$$\beta = (1/n) \min\{g_j \cdot f(\beta_j)\}.$$

The result is that β has to be selected between this lower and upper bound. For C^*, τ_1 and τ_2 boundary values can be derived from what Pastijn and Leysen (1989) call a perfect conflict situation. In such a situation all criteria are of the same type and equally important and both actions or objects are dominating the other one for the half of the criteria with a difference in preference score of m times β (the indifference threshold), or in notation form:

Criteria:	C_1	C_2	C_3	...	C_{n-2}	C_{n-1}	C_n
$\hat{e}_j(a,b)$	$m\beta$	$m\beta$	$m\beta$		0	0	0
$\hat{e}_j(b,a)$	0	0	0		$m\beta$	$m\beta$	$m\beta$

This gives as preference indicators

$$P(a,b) = \frac{1}{n} \sum_{n=1}^{\frac{1}{2}n} g_j(m \cdot \beta) \text{ and } P(b,a) = \frac{1}{n} \sum_{j=\frac{1}{2}n+1}^{n} g_j(m \cdot \beta).$$

If g_j equal for all criteria, then

$$P(a,b) = P(b,a) = \tfrac{1}{2}m \cdot \beta.$$

This means that for indifference, C^* has to be lower than this value.

The thresholds τ_1 and τ_2 are a kind of sensitivity parameters and can be derived from a so called minimal preference perturbation index, indicating the number of couples that have to be switched in the perfect conflict situation before preference is concluded. If it is assumed that for weak preference the scores of p_1 couples have to be switched in favour of object a, the preference indicators are

$$P(a,b) = \frac{1}{n} \sum_{j=1}^{\frac{1}{2}n+p_1} g_j(m \cdot \beta) \text{ and } P(b,a) = \frac{1}{n} \sum_{j=\frac{1}{2}n+p_1+1}^{n} g_j(m \cdot \beta)$$

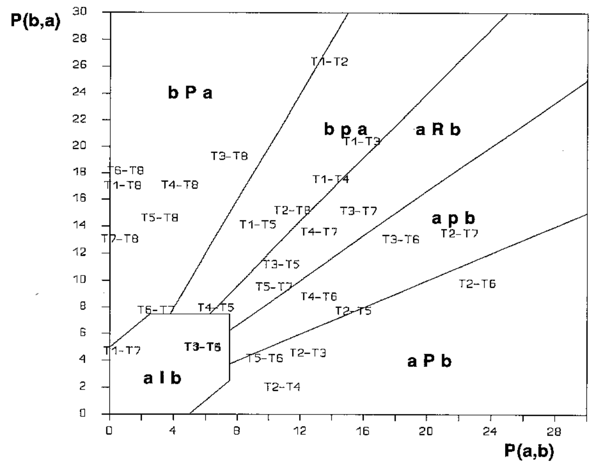


Figure 3. Conflict analysis diagram for the tractor choice problem under the assumption of linear criteria

If g_j equal for all criteria, then

$$P(a,b) = \frac{[(\frac{1}{2}n + p_1)m\beta]}{n} \text{ and } P(b,a) = \frac{[(n - \frac{1}{2}n - p_1)m\beta]}{n}$$

or

$$P(b,a)/(P(a,b) - P(b,a)) = (n - 2p_1)/(4p_1).$$

Thus, for a weak preference situation τ_1 has to be higher than this value. If for strong preference the scores of p_2 (with $p_2 > p_1$) couples have to be switched, the following condition is obtained:

$$\tau_1 \geq (n - 2p_1)/(4p_1) \geq \tau_2 \geq (n - 2p_2)/(4p_2).$$

The boundary values can be represented graphically as well (see, e.g. Figure 3), dividing the conflict analysis diagram into six zones: a zone where the alternatives are considered to be identical (preference intensities are low and nearly equal), a zone of incomparability (preference intensities rather high but nearly equal), two zones of weak preference (substantial difference in the preference intensity indicators) and two zones of strong preference (high difference in the preference indicators).

The results of this conflict analysis for each pair of objects can be put in a matrix (for an example see further). From this matrix a rank order can be derived. Because of possible indifferences and incomparabilities, this will only be a weak order. In certain cases even intransitivities can occur. This can be the case if the following condition is not fullfilled for all criteria:

$$a\ P_j\ b\ P_j\ c \Rightarrow \hat{e}_j(a,c) = \hat{e}_j(a,b) + \hat{e}_j(b,c).$$

This condition will, e.g. not hold for criteria of type I and II (0–1 criteria). Therefore, selecting this kind of preference functions can give problems (cf. the ELECTRE method). However, this does not mean that this kind of functions may not be used, because in real decision making intransitivities can occur as well. In that case the method may be used to elicit the most promising alternatives instead of a global rank order.

Another problem with pairwise comparison is that the rank order of two objects is not always independent of the introduction of new alternatives (Arrow and Raynaud, 1986) or in other words the preference of object a over b can be influenced by the presence or absence of object c. This danger exists if a discontinuous preference function is selected, in particular the rank order function (type V), as in this case the preference scores can change with the introduction of new alternatives.

3. Application

3.1. Basic solution

In this section an application of the CAM method in the field of investment analysis will be discussed but the method can be applied to project analysis (see e.g. Van Huylenbroeck and Martens, 1990, 1992), environmental impact studies (Van Huylenbroeck, 1990a, 1992), policy analysis (Van Huylenbroeck, 1990b), consumer behaviour analysis and other fields as well.

The example is derived from a typical investment choice problem in farm management, the purchase of a tractor. Traditional cost–benefit methods fail in this case because only the cost side is influenced by the choice and because other attributes, besides price and operational cost, will highly influence the choice of the farmers. This can be objective attributes such as technical performances or parameters but subjective criteria as well such as comfort, service, etc.

In the example eight tractors are compared on the basis of ten criteria. The basic data are given in Table 1. The quantitative data are obtained from Hoenderken (1989) and CEMAG (1984). For the other criteria (comfort and prestige) an (own) subjective rank order is given for illustration purposes.

The criteria cilinder capacity, power, maximum torque, torque increase and lifting power are positive criteria, meaning the higher a value, the better. This in contrast with the other criteria for which the rule is the lower the better. The direction of preference has to be taken into account when performing the pairwise comparison.

For the weights, method (b) of Section 2.2 is applied. In the last column a priority rank order is presented putting the price criterion on the first place and some technical features on the second and third position. The ordinal criteria, service and comfort, are ranked on the fourth and fifth place while the fuel criteria (or the main operational cost) is considered to be the least important criterion for this farmer. This is of course only an example. Other rank orders are possible depending on the priorities of particular decision makers.

In the basic variant all criteria are assumed to be of type IV with an indifference threshold q of 0 and a preference threshold p equal to the maximum value of each criterion. In Section 4.2 the influence of some other assumptions will be tested. The outcomes for the preference intensity indicators (multiplied with 100 for notation purposes) of this basic variant are given in Table 2 and represented graphically in Figure 3.

In the conflict analysis a value of 5 is applied for the β-threshold, assuming that the preference score for a criterion has to be at least higher than 5 before preference can be concluded. For C^* a value of 7.5 (or an m-value of 3) is selected and τ_1 and τ_2 are resp. equal to 5 and 1. These threshold values can of course be changed if wanted.

Table 1
Basic data for the tractor choice problem

Criteria	Alternatives								Priority rank
	T1	T2	T3	T4	T5	T6	T7	T8	
Cilinder capacity (cm^3)	3595	5656	5184	5184	3456	3456	3922	4562	2
Power (kW)	48	72	77	63	56	47	51	61	2
Maximum torque (Nm)	223	366	372	309	301	225	255	340	3
Revolution decrease (%)	36	49	31	39	27	38	34	31	3
Torque increase (%)	10	25	16	22	25	22	15	28	3
Lifting power (da N)	2350	4780	3760	3760	3900	2550	2385	3400	3
Fuel consumption (l/h)	15	22	23	19	16	14	16	19	6
Price (1000 BF)	914	1812	2075	1889	1543	1218	976	947	1
Comfort (ranks)	7	1	4	2	3	5	6	8	5
Service (ranks)	2	1	3	3	3	3	2	2	4

Table 2
Preference intensity indicators $P(a,b)$ for the basic variant of the tractor choice problem

First action	Second action							
	T1	T2	T3	T4	T5	T6	T7	T8
T1	0.00	13.83	15.88	13.95	9.34	5.85	0.80	0.84
T2	26.31	0.00	12.53	10.91	15.42	23.18	22.06	11.52
T3	20.33	4.50	0.00	5.88	10.83	18.39	15.70	7.52
T4	17.47	1.96	4.96	0.00	6.70	13.22	13.22	4.41
T5	14.07	7.67	11.11	7.90	0.00	9.79	10.35	3.15
T6	4.89	9.74	12.97	8.73	4.11	0.00	2.92	1.01
T7	4.63	13.40	15.08	13.52	9.45	7.71	0.00	0.67
T8	16.96	15.15	19.19	16.99	14.54	18.08	12.96	0.00

The results of the conflict analysis are presented in Table 3. The $\gg$-sign indicates a strong preference, the $>$-sign a weak preference, the *I*-sign an indifference and the *R*-sign a conflict or incomparability situation. From this matrix a rank order can be derived as indicated in Figure 4 (variant 1). Notice the supplementary information given by the matrix because graphically it is difficult to make distinction between weak and strong preference and between indifference or incomparability.

3.2. Sensitivity analysis

The results can be sensitive to modifications in the criterion scores or to modifications in the priorities or weights. The sensitivity for modifications in the criterion scores can be tested by changing the type of preference curve while the sensitivity for changes in the priorities can be analysed by testing a number of different weight-sets or by changing the threshold values.

For the first type of sensitivity analysis the following variants have been compared:
- variant 1: basic variant;
- variant 2: all criteria of type I (0–1 criteria);
- variant 3: all criteria of type V (rank order criteria);
- variant 4: all criteria of type III (multi level criteria).

In the case of variant 4 equal step-intervals are used with following specifications (step and maximum difference p for absolute preference):

– Cilinder capacity (cm^3):	step = 500	and $p = 2000$
– Power (kW)	10	50
– Maximum torque (Nm)	25	200
– Revolution decrease (%)	5	30
– Torque increase (%)	5	20

Table 3
Results of the conflict analysis for the basic variant of the tractor choice problem

First action	Second action							
	T1	T2	T3	T4	T5	T6	T7	T8
T1	*I*	<	<	<	<	*I*	*I*	≪
T2	>	*I*	≫	≫	>	≫	>	<
T3	>	≪	*I*	*I*	*R*	>	*R*	≪
T4	>	≪	*I*	*I*	*R*	>	*R*	≪
T5	>	<	*R*	*R*	*I*	≫	*R*	≪
T6	*I*	≪	<	<	≪	*I*	≪	≪
T7	*I*	<	*R*	*R*	*R*	≫	*I*	≪
T8	≫	>	≫	≫	≫	≫	≫	*I*

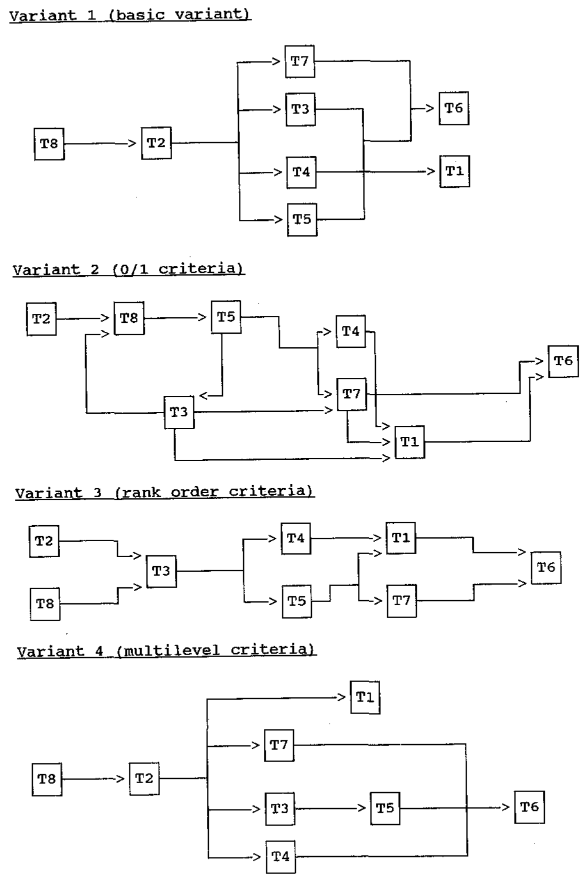


Figure 4. Rank orders obtained by the four variants

– Lifting power (da N)	500	3000
– Fuel consumption (l/h)	2	10
– Price (1000 F)	100	1000
– Comfort (ranks)	1	7
– Service (ranks)	1	2.

In Figure 4 the results of the four variants are compared. As already indicated in the theoretical part, variant 2 gives problems because of the intransitivities due to the 0/1 type of preference function (T8 > T5 and T5 > T3 but T3 > T8). Although between the other variants slight modifications in the rank order can be observed, the general conclusion can be that T8 and T2 are the better choices and that this result is not very sensitive to modifications in the criterion scores. It is of course not obligatory to select for all criteria the same type of preference function. Here only extreme situations are compared. In practice mixed data are possible and most common.

For the analysis of the sensitivity for changes in the priorities, distinction has to be made between:

- sensitivity for changes in the rank order;
- sensitivity of the CAM results for a particular rank order.

The first type of sensitivity can be simply analysed by running the program for a number of different rank order sets. Testing the consequences of different rank orders is only useful if the decision maker does not feel sure about his priorities or if there is more than one decision maker (e.g. in policy analysis).

The second type of sensitivity test analyses the sensitivity of the g_j-factor estimation in formula (2). As indicated this sensitivity can be tested by generating a random sample of weight sets meeting the

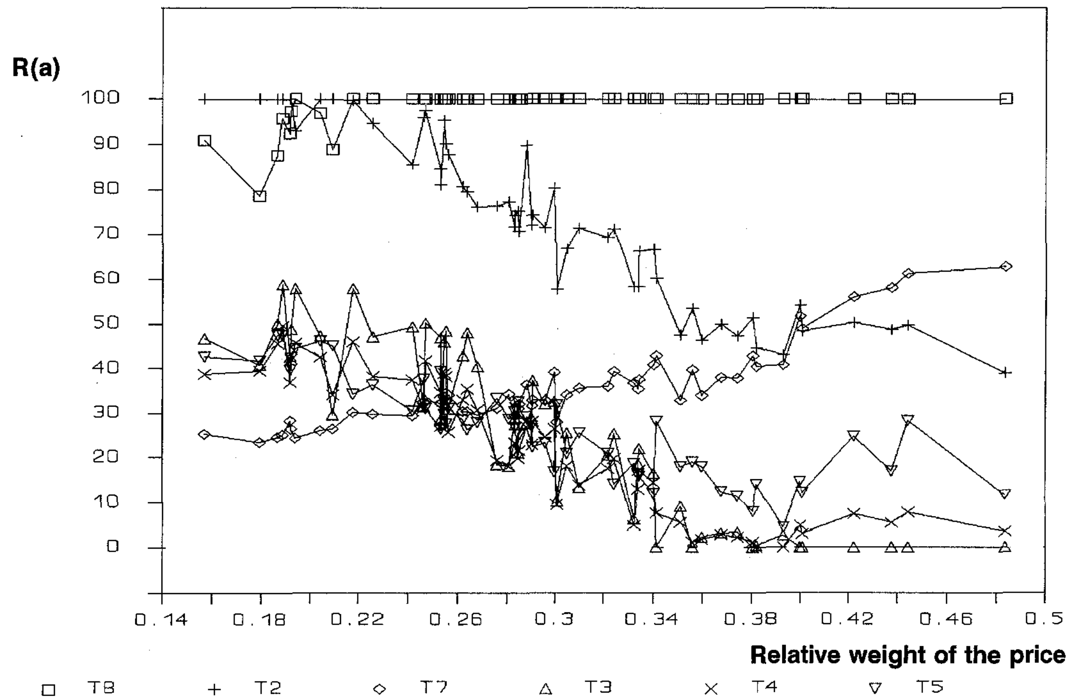


Figure 5. Sensitivity analysis on the relative weight of the price

conditions imposed by the ordinal rank order. Rietveld (1989) gives an operational approach to draw such a sample on the basis of a standard random generator.

In Figure 5 the results of this sensitivity test are presented. On the abscis the relative weight of the most important criterion is indicated, while on the vertical axis the relative distance between the objects is plotted. This distance is calculated by rescaling following values in the 0–100 interval:

$$\text{For all alternatives } a: \quad R(a) = \sum_i P(a,i) - \sum_i P(i,a). \tag{3}$$

If the weight of the price criterion is less than about 20%, tractor 2 obtains the highest score, but the distance with tractor 8 remains small. Between 20% and 25% it depends on the relative weight of the other criteria which alternative is ranked on the first place. However, if the weight given to the price is more than 25% tractor 8 forms clearly the best choice. This means that in the majority of the cases T8 is dominating T2. This is the reason why by the CAM method a preference situation is indicated.

Also the difference between incomparability and indifference can be observed. For small weights T7 is worser than the other alternatives while for higher weights it is the opposite. This explains why between T7 on the one hand and T3, T4 and T5 on the other hand an incomparability situation is indicated, while between T3 and T4, e.g. for which the positions are always close an indifference situation is concluded.

Another way to analyse the sensitivity of the g_j estimation is to change the threshold values for β, C^*, τ_1 and τ_2. Increasing the value of β and C^* will enlarge the indifference zone, while decreasing the values of τ_1 and τ_2 will increase the incomparability and weak preference zones.

4. Conclusion

In this article a general model for multicriteria analysis, called the Conflict Analysis Model is presented. The method combines the preference function approach of ELECTRE and PROMETHEE with the conflict analysis test of ORESTE. This creates a more general framework for the analysis of discrete multicriteria problems.

The method is flexible enough to handle all kind of problems no matter whether the data are quantitative or qualitative. If the decision maker is able to formulate the hierarchy of the criteria, conflicts between alternative options can be analysed. But even if this is not the case, the method can be used to study the consequences of different viewpoints as the sensitivity of the results for changes in data or priorities can easily be analysed. Further developments of the method have to focuss on the elicitation of the preference functions by applying techniques used in Multi Attribute Utility Theory, expert systems, risk measurement, etc

As shown in other papers the method is not limited to investment decision problems but can be applied to other decison problems as well. All real world applications indicate that the methodology can easily be applied to large data sets and that the model is very accessible to decision makers who are not familiar with MCDM.

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