



Le LAMSADE organise une manifestation scientifique en hommage à son fondateur, Bernard Roy, décédé le 25 octobre 2017.

Bernard Roy était le président d'honneur de la ROADEF.

La manifestation aura lieu le vendredi 29 juin, à 15h00 dans la salle Raymond Aron de l'Université Paris Dauphine.

Le programme sera le suivant:

- 15.00 – 15.15 Mots de bienvenue.
Isabelle Huault & Bruno Bouchard
- 15.15 – 15.45 Hommage à Bernard ROY.
Denis Bouyssou
- 15.45 – 16.00 Bernard Roy: la RATP et Cerisy.
Edith Heurgon
- 16.00 – 16.15 Bernard Roy: le LAMSADE.
Daniela Grigori, Vangelis Paschos & Alexis Tsoukiàs
- 16.15 – 16.45 Les contributions de Bernard Roy à l'aide multicritère à la décision.
Vincent Mousseau
- 16.45 – 17.00 Bernard Roy: le Groupe de Travail européen AMCD.
José R. Figueira
- 17.00 – 17.30 Les contributions de Bernard Roy à une science de l'aide à la décision.
Albert DAVID
- 17.30 – 17.45 Bernard Roy: le DEA 103.
Armand HATCHUEL
- 17.45 – end Cocktail



Opinion Makers Section

Architecture and MCDA: open challenges on the border

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Architecture between Theory and Practice

In the last decade, a growing literature that intertwines the themes of architecture and those of the Multi Criteria Decision Aiding (MCDA) has flourished, starting from a series of researches carried out in several Italian Universities which has then given rise to international collaborations, as shown in last EWG meetings.

If for MCDA experts it is clear that the family of approaches and tools of multicriteria is vast, perhaps it is not so obvious to say that the "decision support" required in the architectural field can vary considerably depending on the meaning placed on architecture.

The idea of high-quality architecture (Davos Declaration, 2018), able to fulfil functional, technical and economic requirements, as well as to satisfy people's social and psychological needs, can explain the increasing recourse to MCDA for supporting design processes in the architecture domain. Furthermore, according to its ethymological roots, the project is an anticipation of future potentials. It is a kind of research that, even without a clear representation of the outputs, finds in the identification of the problem the potentials to achieve several and often conflictual goals (Nardi, 2001). Therefore, the architectural design is a cyclical and incremental pattern rather than a linear one, subjected to gradual reviews according to the objectives and constraints of the decision context (Fanzini et al., 2017; Gritti et al, 2018) and in between knowledge – by the selection of the relevant elements for the alternatives'

definition – and practice – by a real alteration activity (Bovati, 2004). Today, more than in the past, the debate about the theory of architecture is focused on the effects of the project, the "implications concerning both the ways in which the project produces effects IN the world, institutionalizing and making a concrete outcome, and the ways in which the project produces effects ON the world, modifying its boundaries and the density of its bonds" (Armando & Durbiano, 2017, p. 265, our translation and use of the capital).

Architectural projects, especially in their preliminary phases, cross symbolic and bureaucratic issues that are often inextricable. The function of the project is both to agree the actors on the future actions to be undertaken ("symbolic exchange"), and to make the actions conform to technical procedures of various kinds ("bureaucratic exchange"). The symbolic exchange is typical of the context of discussion and decision in which the project conveys the representation of objectives and alternatives to be realised, while the bureaucratic exchange characterises the formalised procedures of approval, authorisation and contracts (Armando & Durbiano, 2017).

The research and applications of MCDA have covered the first issue, the symbolic one, through the structuring and definition of the problems, the selection of the criteria, the identification of the alternatives as possible solutions to the decision problem; while the discussion on the bureaucratic exchange (through the drafting of documents to support the decisions that are contracted) is for the moment more related to the Problem Structuring Methods - PSMs (Todella et al., 2018).

Challenges

Whatever the architectural theory of reference, the specific context presents a series of peculiarities that correspond to as many challenges for the experts of MCDA:

- *The temporal dimension.* The transformation of a building, as well as the construction of a land, are the product of an on-going social process that is enabled (guidance, support) and constrained (limitations, prohibitions) by a sequence of agreements and plans. At the same time, they are physical phenomena which imply a more or less long period of time for their realisation, during which the conditions of the decision-making process can change deeply and, consequently, within the MCDA, the alternatives, the criteria, the weights, the preferences, etc.
- *The composition of the decisional network.* In the past, the subjects involved in the construction processes were essentially the owner of the area, the developer and the users, many times coinciding in a single figure. Today urban development, even just at the scale of a building, involves different categories of individuals and organisations with different stakes and power to influence projects (Dente, 2014; Yang, 2014). In

a situation of high institutional and social fragmentation, the power of veto is in fact multiplied. It does not refer only to the traditionally strong interests, but also to the traditionally weak interests. Groups that are not directly engaged in the decision processes have the possibility to stop the choices made by others, or at least to delay them;

- *The material and immaterial implications of the project.* The implications of an architectural project concern aspects related to several factors: technical-productive (i.e. which technological elements are used for constructions); aesthetics (i.e. what shape, which materials, how to integrate it within the context); economic (i.e. how much is the investment value; which is the expected return); social (i.e. how to minimise gentrification phenomena; how to meet communities' needs); regulatory (i.e. which are the requirements it has to satisfy) and institutional (i.e. which authorisations should be obtained). The architecture gives rise to a socio-technical product: in this sense the MCDA constitute the only approach able to simultaneously evaluate all the aspects;
- *The relationship between cause and effect.* Architectural projects, as well as urban plans, can ensure direct effects (e.g. the realisation of a shopping mall or a square) but not desired and claimed side effects (e.g. the shopping mall will be profitable and lead to the economic revitalisation of the surrounding area, the square will be popular). The effect of a project cannot be determined linearly from the origin: the final state achieved does not always correspond to the expected one (Armando & Durbiano, 2017). Furthermore, the effect of an architectural project and of a plan can be much more than the physical transformation of the urban fabric: its media coverage, plans, standards, other projects, etc. The achievement of the latter is hardly negotiable and measurable (Healey, 2007). According to the two geometries identified by Michel Serres as peculiar of the history of Western thought (Serres, 1993), design activity is in between intellectual speculation and achievement of functional and economic purposes (Gritti et. al., 2019). Thus, architectural project can be considered as a "Science Research Stream", where quantitative and qualitative data are gathered in an effort to uncover the 'real' problem and its underlying structure, as well as a "People Stream", where problems are individual and/or social constructions of differing realities, so problems do not exist as concrete entities, but from different point of views (Corner et al., 2001).

Insights from recent literature on the border

With respect to these challenges, in the last years the research on the border between the architecture domain and MCDA has been mainly addressed to explore both the *material and immaterial implications* of the projects and the *relationship between cause and effect*. Within the short body of literature devoted to explore how to support design processes in the architecture domain by MCDA, most of the efforts have been focused on structuring the decision problem, rather than on the evaluation of alternatives.

The awareness about the coexistence of several expectations, values and preferences of those responsible for and affected by decisions has stressed the importance of multi-methodological approaches based on the combination of different methods and techniques aimed at handling ill-structured decision problems (Marttunen et al, 2017).

Observing the recent literature about MCDA and architecture, what emerges clearly is the use of integrated approaches that combine different methods, more or less structured, depending on the phase of the decision-making process and the data available. Different methodologies in the field of Problem Structuring Methods (PSMs) have been experimented with the aim of actively support the preliminary stages of design activities, when decision problems and processes have to be structured, uncertainties analysed and technical and/or organisational solutions developed and evaluated (Norese et al. 2015; Todella et al., 2018; Tavella & Lami, 2018). Besides the PSMs, we also observe a first recognition of the problem by means of even just a SWOT analysis, followed by the application of a MCDA. Among the latter, within the EWG studies the most applied appear to be: NAIAD (Oppio and Bottero, 2017; Oppio et al., 2017); AHP (Abastante et al., 2018), ANP (Abastante, 2016, Abastante & Lami, 2012) MAVT (Ferretti et al., 2014), Choquet integral (Bottero et al., 2018), and CAT-SD (Costa et al, 2018).

Working on the border between Architecture and MCDA is a current and interesting challenge for the EWG group, where mathematics meets the materiality of space and models must take up the challenge of representing a world very far from the theory.

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Forum Section

How ELECTRE Tri and the combined action of two SW tools can be used to create a robust model

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Introduction

A preliminary study that orients the attention of stakeholders, or potentially involved actors, towards the specific nature of a problem may facilitate situations that are characterized by new, complex and not well structured problems. This preliminary study may be described as a simulated decision aid approach, because the decision process and system are in a pre-decision phase, but it may also be described as a stimulating approach, because the study is developed together with a few actors that perceive the need to understand and propose structured elements for later phases of a still not activated decision process. This SIMulated and STImulating (SISTI) approach uses the application of a method to formal models and the analysis of the results of these applications, in order to orient and control the process, and to document the adopted logical paths and the main steps of the learning process.

SISTI has been applied to aid some decision makers in Public Administrations (Norese, 2009 and 2010; Norese and Carbone, 2014), and a systematic analysis of this approach has been proposed (Norese, 2016 and 2016a). The latest SISTI application has been developed in relation to a research ambit that studies the several aspects that can increase society's resilience to disasters of a human and natural origin. An MC model was elaborated in 2014, in relation to a pilot case, to both underline the limits of the adopted resilience indices and to demonstrate, by means of the application of an MC method to a resilience model, that MC models and methods "exist" and can be very useful in resilience increasing processes (Scarelli and Benanchi, 2014). ELECTRE III (Roy, 1998) was used to synthesize the evaluations and rank the analysed territorial units (21 municipalities from the Ombrone basin in the

Tuscany region of Italy) from the most to the least resilient. Starting from the results of this study, a SISTI application was carried out to test and improve the model. This analysis is described in detail in (Norese et al., 2016 and Norese and Scarelli, 2016). The updated model produced more interesting results, but it was still not able to produce a clear ranking of all the municipalities, because several incomparability situations between the municipalities were always present, unexplainable and not so consistent with the high quality of the model parameters. A more detailed analysis of these "strange" municipalities led to the conclusion that it was possible that a "natural" incomparability existed between them, and the use of the ELECTRE Tri method (Roy and Bouyssou, 1993) was proposed to assign the municipalities to resilience categories.

The new SISTI cycles, this time obtained with ELECTRE Tri, are described in this paper. The main factors that characterize the SISTI approach are described in the first section. The methodological results of the SISTI approach with ELECTRE Tri are analysed in the second section in relation to the resilience problem. What is necessary to make SISTI less demanding in practice is synthesized in the conclusions.

1. The SISTI approach

The logical sequence of activities of the SISTI cycles is described in Figure 1. The Input includes a draft MC model, which may be taken from literature, may be the expression of the experts in the involved fields or may be set up directly on the basis of the examined context, and the result of an application of an MC method to this model. The identification (ID) of the main characteristics of the result is the first activity, which orients the development (D) of a sensitivity analysis (SA) of the result, in relation to its identified characteristics. The SA results have to be structured in an easily understandable framework that can be used in a communication context (Com/ID) to visualize the results and identify elements that may be useful for an improvement of the model. The development (D) of model improvement proposals and new method applications to the new model versions generates new results.

These results have to be structured in an easily understandable synthesis framework and verified through collective testing (CO, as in Communication and Control of the procedure), to verify the validity of the changes, in terms of model improvement. The validity can only be partially verified and may require a new cycle of SISTI (New, after CO), with new activities oriented in the same direction or towards a revision of some previous changes (procedure control activity). Only when the modelling hypotheses and the last formal model have been considered acceptable (Acc, after CO), can a robustness analysis be developed (D) in a new SISTI cycle, with the aim of testing the robustness of the model (rather than the robustness of the results). The robustness analysis results

have to be synthesized and collectively verified (CO) in order to stop the process or to activate a new SISTI cycle. Sensitivity and robustness analyses are not so different, in terms of activities, but their aims are somewhat different. SA is developed in the SISTI cycles to orient the model evolution; a robustness analysis is only activated at the end, to verify the robustness of the final model. Several possible paths and modelling hypotheses can be proposed and tested iteratively in this knowledge structuring context, until the conceptual structure of the problem and its model are considered consistent with the situation.

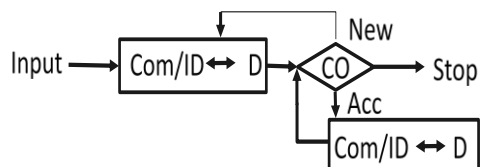


Figure 1- The SISTI cycles

2. ELECTRE Tri and the SISTI cycles

The ELECTRE Tri method (Roy and Bouyssou, 1993) has been applied several times in the new SISTI cycles, in three different phases of the modelling process. The first application was aimed at testing and improving the draft model, the second at analysing the results of the new model, which had been generated in the first phase, and the third at developing a robustness analysis of the model. The SW ELECTRE TRI 2.0 tool (Mousseau et al., 1999) tool was able to facilitate this learning process, above all because of its easy visualization of alternative and categories. The SW Ulaval tool (Abi-Zeid et al, 2015) was integrated with the aforementioned tool, above all because of its ability to run a clear and complete stability analysis. The phases and the activities of each cycle are described in this section, after a description of the draft model.

2.1 The draft model

An ELECTRE Tri model consists of all the components and parameters of an ELECTRE III model, but it also has as component a reference system that includes the categories and the profiles that characterize the categories. In this application, the criteria and parameters of the ELECTRE III model, which resulted from the previous SISTI cycles (see Norese et al., 2016 and Norese and Scarelli, 2016), were used to start.

Table 1 synthesizes the structure of the model (dimensions and criteria) and the different sets of relative importance coefficients that were defined and used in the previous SISTI cycles. Six possible situations can be distinguished: when the three dimensions have the same importance (balanced model), when 50% of importance is assigned to one of the dimensions and 25% to each of the others (three scenarios), and in relation to two possible Policies, which were defined in relation to a possible decision process of a territorial agency that needed structured knowledge before

any resource allocation could be made. The draft model for the first application of ELECTRE Tri also included three categories that were defined in relation to the problem of resource allocation and to the nature of the previous classification problem statement: a clear distinction of the municipalities into three classes rather than a ranking. The categories and their operational implications were: Rejected request of funds (Bad), in the presence of generally bad performances or local critical evaluations; Financial support only in the presence of specific guarantees (Intermediate), intermediate performances in almost all the aspects; Financial support (Good), in the presence of medium-high performances in environmental and social Awareness, low Risky behaviour and good Reaction capability.

Table 1- Structure of the model and sets of weights

Dimensions Criteria Sets of weights	Risky behaviour		Awareness		Reaction capability	
	CO2 Emission	Urbanization	Environmental awareness	Progress in social life	Reaction time	Territorial desirability
Balanced	0.16	0.17	0.17	0.16	0.17	0.17
Scenario 1	0.25	0.25	0.13	0.12	0.12	0.13
Scenario 2	0.12	0.13	0.25	0.25	0.12	0.13
Scenario 3	0.12	0.13	0.13	0.12	0.25	0.25
Policy 1	0.17	0.18	0.20	0.20	0.12	0.13
Policy 2	0.15	0.15	0.15	0.15	0.20	0.20

The other parameters of the model, the veto (v), indifference (q) and preference (p) thresholds, are included in Table 2, with the profiles that define the categories (the vectors that express the two extreme values of the used scales and the two proposed internal profiles) in the original ELECTRE Tri method (nowadays referred to as ELECTRE Tri B). The balanced weights and an intermediate value of the cutting level ($\lambda = 0.65$, neither too high not too low) were used in the ELECTRE Tri application to the draft model. The first activities of a SISTI cycle were a critical analysis of the result of this application and the development of an SA.

Table 2 - Scales, thresholds and reference actions

Criteria [used scales], veto-v, indifference-q and preference-p thresholds	Profiles that separate the three categories			
CO2 Emission [7-1], v=5	7	5	3	1
Urbanization [2-0,1], v=1.2, q=0.1, p= 0.2	2	1	0.4	0.1
Environmental aware. [14.9-54.2], v=25, q=0.5, p=2	14.9	35	45	54.2
Progress in social life [0.38-0.519], q=0.01, p=0.02	0.38	0.42	0.47	0.519
Reaction time [0.76-0.49], v=0.19, q=0.02, p=0.04	0.76	0.68	0.58	0.49
Territorial desirability [1.39-19.29], v=10, q=0.4, p=1.5	1.39	4	10	19.29

2.2 The first phase of result analysis and model evolution

The second phase of an ELECTRE Tri application assigns each action to a category by means of one of two versions of the assignment procedure, a pessimistic one or an optimistic one. The choice of which of these versions

depends on the decision maker's attitude to the decision. When the decision makers are not involved in the decision aiding process, the two versions of the procedure should be used together. The analysis of the two results, and above all of their differences, is essential to identify any possible signs of weakness in the model: a different assignment may be related to the nature of an action and its evaluations or to the possible weakness of some model parameters (often too restrictive cutting levels or veto thresholds).

The result of the balanced model (balanced weights and intermediate \square presented some possible signs of model weakness, concerning the almost total assignment of the municipalities to the Intermediate category (see Table 3), together with the very limited or no assignment to the Bad category.

Table 3: Synthesis of the assignments of 21 actions (cutting level $\lambda=0.65$)

Categories	Pessimistic procedure	Optimistic procedure
Good (Financial support)	CASTE, GAIOL, RADDA, MONGG (4/21)	CASTE, GAIOL, RADDA, MONGG, SOVIC, SANQ, MONTE, CHIUS (8/21)
Intermediate (Need of guarantees)	(15/21)	(13/21)
Bad (Rejected request)	SARTE, SANGI (2/21)	—

ELECTRE Tri was then applied another fifteen times, to develop (D) a sensitivity analysis of the result in relation to the weights and cutting level. The ULaval SW tool is able to calculate stability intervals, in relation to the different parameters (weights, thresholds and cutting levels), for each ELECTRE Tri result. Therefore, new logically admissible parameters, just outside the intervals of stability of the previous result, were used each time ELECTRE Tri was applied.

The sixteen results were: four in relation to the balanced weights and different cutting levels (0.650, 0.661, 0.671, 0.681); four in relation to the first scenario and to the three changes in the weights outside the stability intervals of each previous result; two for the other two scenarios, and four in relation to two changes in weights for each scenario (see Table 4, where the number of times each municipality was assigned to the same category, or to different categories, in the pessimistic or optimistic procedures is indicated). The last column includes an overall judgement of each municipality, which was achieved by collectively analysing the results (Com/ID). Three municipalities were identified as Good (G, when a majority of the assignments were Good in both of the procedures, and the others were Intermediate- Good), ten as "between Intermediate and Good" (I/G) and four as Intermediate (I). The other four municipalities were identified as "between Bad and Intermediate" (B/I) (SARTE), as "strange but oriented towards the Bad category" (S→B) (SANGI), because an assignment to the Bad category in the pessimistic procedure and to the Good one in the optimistic procedure can be defined "strange". Two municipalities (CASTI and MONTI) resulted to be

"strange" (S), as their assignments were oriented towards both Bad and Good.

Table 4 - Synthesis of the results after the sensitivity analysis

Classes Actions-municipalities	Good - Good	Intermediate - Good	Intermediate - Intermediate	Bad - Good	Bad - Intermediate	Bad - Bad	Whole judgment
RADICOFANI (RADI)			16				I
SARTEANO (SARTE)			4		12		B/I
PIENZA (PIENZ)		7	9				I/G
SAN QUIRICO D'ORCIA (SANQ)		16					I/G
CASTIGLION D'ORCIA (CASTI)		4	5	2	5		S
MANTALCINO (MONTA)	2	9	5				I/G
MURLO (MURLO)		6	10				I/G
BUONCONVENTO (BUONC)		8	8				I/G
SAN GIOVANNI D'ASSO (SANGI)			2	1	13		S→B
TREQUANDA (TREQU)		6	10				I/G
ASCIANO (ASCIA)			16				I
MONTERONI D'ARBIA (MONTE)		14	2				I/G
RAPOLANO TERME (RAPOL)			16				I
CASTELNUOVO BER. (CASTE)	7	9					G
GAIOLE IN CHIANTI (GAIOL)	7	4	5				I/G
RADDA IN CHIANTI (RADDA)	9	7					G
MONTERIGGIONI (MONGG)	9	7					G
SOVICILLE (SOVIC)	5	3	8				I/G
RADICONDOLI (RADIC)			16				I
CHIUSINO (CHIUS)		15	1				I/G
MONTICIANO (MONTI)		6	8		2		S

This SA confirmed the original remarks on the result characteristics, even though only four municipalities were now Intermediate: some municipalities may have become Good, after changing some parameters, but none became Bad. A procedure was developed (D) in relation to this remark in order to perceive the quality of the proposed categories and their separation elements (the two low and high profiles) more clearly.

It is possible to obtain a clear visualization of the categories in the SW ELECTRE TRI 2.0 tool in a window where the profiles that separate the three categories are highlighted. This visualization facilitates a verification of the profile quality or an improvement of this quality. As an example, the sizes of the external categories (Bad and Good) seem similar in Figure 2 and the Intermediate category is the smallest. However, the situation may be different. The size of each criterion is visualized in the window in relation to the worst and best evaluations of the analysed actions but can change if a new action is included or another is eliminated.

This feature activated an analysis of the performances, in relation to the Territory Desirability criterion. It underlined that the performance of San Quirico d'Orcia (19.29) was very different and better than the others in the used scale between 1.39 and 19.29. The second best was Pienza (13.68), but it was very far from the previous one. A temporary elimination of San Quirico d'Orcia changed the visualization of the profiles in relation to the Territory

Desirability criterion (see figure 3). This result generated a whole new analysis of the evaluations, and the presence of similar situations became evident in another three criteria. The temporary elimination of the outlier each time, and their combined elimination, underlined that the Intermediate category was too large in relation to the others (see figure 4). A change proposal was formulated in relation to two criteria and it was tested through an application of ELECTRE Tri with the balanced parameters.

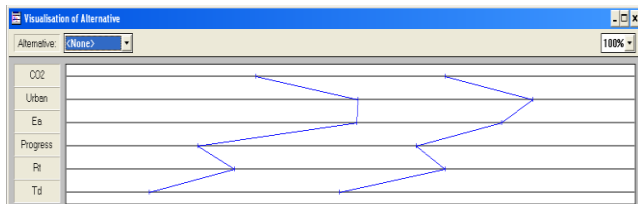


Figure 2 - Visualisation of the profiles

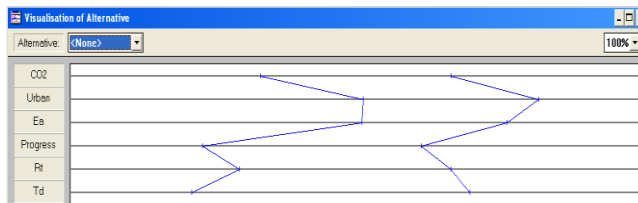


Figure 3 - Visualisation of the profiles after the elimination of San Quirico d'Orcia

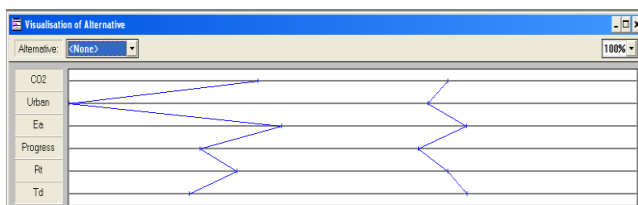


Figure 4 - Final visualisation of the profiles

An interesting result was achieved and this stimulated a second change in relation to four criteria (see Table 5) and a new application of the method. The results are synthesized in Table 6: for the first time, two municipalities were assigned to the Bad category in both of the procedures, several fell into the Bad-Intermediate category and one into the Bad-Good category in the balanced model. The Intermediate-Intermediate number became less than 50 % of the whole set, at least in one procedure. A collective analysis was activated, and the proposal of a new model was considered interesting and was accepted (CO, communication and control of the procedure). For these reasons, a new phase was activated to better analyse the results of the new model.

Table 5 - New reference actions (the values in bold were changed)

Criteria [used scales]	Profiles that separate the three categories			
CO2 Emission [7-1]	7	5	3	1
Urbanization [2-0,1]	2	0.7	0.4	0.1
Environmental awareness [14.9-54.2]	14.9	35	45	54.2
Progress in social life [0.38-0.519]	0.38	0.44	0.48	0.519
Reaction time [0.76-0.49]	0.76	0.65	0.57	0.49
Territorial desirability [1.39-19.29]	1.39	6	10	19.29

Table 6 - Synthesis of the assignments (new model, cutting level $\lambda=0.65$)

Categories	Pessimistic	Optimistic
Good	CASTE, GAIOL, RADD, MONGG (4/21)	CASTE, GAIOL, RADD, MONGG, SANQ, MONTE, CHIUS (7/21)
Intermediate	(10/21)	(12/21)
Bad	SARTE, PIENZ, SANQ, CASTI, SANGI, RADIC, MONTI (7/21)	SARTE, RADIC (2/21)

The result analysis procedure underlined a particular characteristic of some results: the presence of municipalities that were assigned to the Bad and Good categories in the SA, in the same ELECTRE Tri application or in different applications of the method. A visualization procedure of these "strange" actions was developed (D plus Com/ID) and it pointed out that the evaluations of these municipalities were too conflicting and their assignment was therefore difficult. One example is CASTI, which resulted to be Intermediate in the balanced model, while it was identified as a "strange" element by SA, an indication that the visualization confirmed: the evaluations of CASTI (see Figure 5) did not fall into the Intermediate category, but four fell in the Bad category and two in the best part of the Good category.

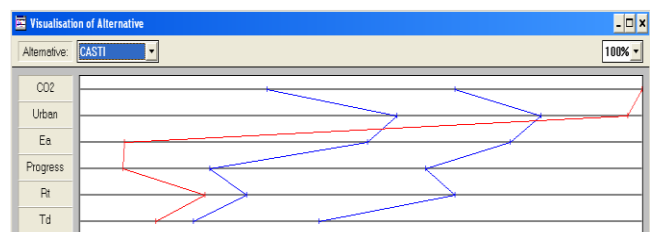


Figure 5 - Visualisation of Castiglion d'Orcia

2.3 The new model result analysis (second phase)

An SA of the new model result was developed in the second phase. Again this time, the cutting level was changed three times, each time just outside the stability interval. The three weight scenarios were only tested in relation to $\lambda=0.65$, but this time the weights related to Policy 1 and Policy 2 were included in the SA. The result, in relation to Policy 1, was very sensitive to these weights

and their changes, and the stability analysis was therefore used six times to analyse the different results, each time in relation to small changes in the weights. The result, in relation to Policy 2, was very stable: after the first change, the stability interval was wide. The synthetic visualization of this SA in Table 7 includes eleven results, four for the original and the other cutting levels, three in relation to the three scenarios and four results for the two Policies .

Table 7 shows the results of the SA and the final judgement, where there are only three Intermediate (I) municipalities, while three are Bad (B) and another three are "strange and oriented towards B" (S→B). Four municipalities are Good (G), four are between Intermediate and Good (IG) and two are "strange and oriented towards Good" (S→G). Two are "strange" (S), oriented towards both Bad and Good.

Table 7 - Synthesis of the SA in the second phase

Actions	Classes	Good - Good	Intermediate - -Good	Intermediate - Intermediate	Bad - Good	Bad - Intermediate	Bad - Bad	Whole judgment
RADICOFANI (RADI)				11				I
SARTEANO (SARTE)						6	5	B
PIENZA (PIENZ)					5	6		S→B
SAN QUIRICO D'ORCIA (SANQ)			2		9			S→G
CASTIGLION D'ORCIA (CASTI)					4	7		S→B
MANTALCINO (MONTA)			7	4				I/G
MURLO (MURLO)			5	6				I/G
BUONCONVENTO (BUONC)			3	2	3	3		S
SAN GIOVANNI D'ASSO (SANGI)						11		B
TREQUANDA (TREQU)			1	5	3	2		S
ASCIANO (ASCIA)				11				I
MONTERONI D'ARBIA (MONTE)			5		6			S→G
RAPOLANO TERME (RAPOL)				11				I
CASTELNUOVO BER. (CASTE)	5		6					G
GAIOLE IN CHIANTI (GAIOL)	5		2	4				G
RADDA IN CHIANTI (RADDA)	6		5					G
MONTERIGGIONI (MONGG)	6		3	2				G
SOVICILLE (SOVIC)	3			8				I/G
RADICONDOLI (RADIC)						7	4	B
CHIUSDINO (CHIUS)			11					I/G
MONTICIANO (MONTI)					4	7		S→B

At that point, the results were compared with an external logic of evaluation and its results, i.e. the rankings that were developed at the end of the previous SISTI cycles through the applications of ELECTRE III (Norese et al., 2016 and Norese and Scarelli, 2016). This method was used in relation to different scenarios, but without arriving at a clear ranking. However, an evident distinction of three categories was obtained, and this could be compared with the SA results.

Three municipalities were always in the worst positions in the rankings: SARTE, RADIC and CASTI. Another four were near to the last in the rankings (SANGI, RADI, MONTI and ASCIA). In the ELECTRE Tri assignments,

only SARTE, RADIC and SANGI were clearly oriented towards the Bad category, while PIENZ, CASTI and MONTI were "strange" and oriented towards the Bad category.

The indications for RADI and ASCIA were different. Another nine municipalities were in the best positions, or near the best, in the rankings, and Good or IG in the ELECTRE Tri SA, with the exception of BUONC, which was defined "strange" (S) in the ELECTRE Tri SA. RAPOL was in the intermediate position of the ELECTRE III rankings and in the Intermediate category in the ELECTRE Tri SA.

Some municipalities were defined "strange" in ELECTRE Tri, above all SANQ and MONTE, and also BUONC and TREQU. An action that presents different results in the ascending and descending distillations is included in ELECTRE III in a lateral path in the final partial graph. A lateral path can indicate several incomparability situations with the other actions and a difficult definition of a position in the ranking. This situation could once again be defined "strange". In the final rankings of ELECTRE III, the municipalities with the maximum number of incomparability situations with the others were SANQ and MONTE, but also TREQU.

The results of the two methods were not consistent in four cases: PIENZ, BUONC, RADI and ASCIA. A visualization of their performances (see, for instance, Figures 6 and 7) underlined that the ELECTRE III results were less convincing, in these cases, than in the sorting approach.

A new, collective procedure control (CO) activity, conducted at the end of the second phase, verified that the changes could be improvements of the model: the SA of the new model confirmed that the signs of model weakness had been removed (only three Intermediate municipalities, the others oriented towards the Good or Bad categories) and the comparison with an external body of knowledge produced completely satisfactory results. Therefore, the new model was considered acceptable, in terms of quality of the distribution to the categories, internal consistency and external validity of the assignments. The CO stopped the SISTI iterations of the second phase and activated the last phase: a Robustness analysis of the new model.

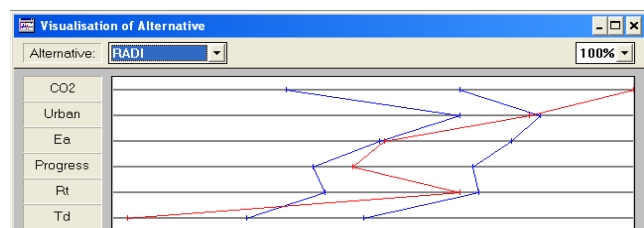


Figure 6 – Visualisation of Radicofani

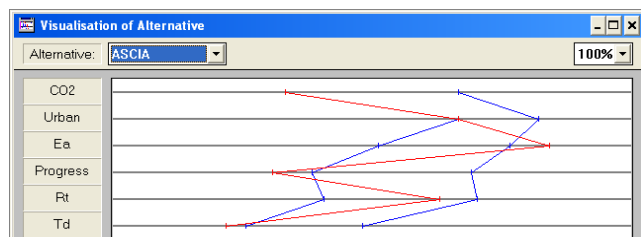


Figure 7 – Visualisation of Asciano

2.4 Robustness analysis

The robustness analysis was developed in relation to the results of the ELECTRE Tri applications to the new model (new profiles, $\lambda=0.65$ and balanced weights) and then in relation to the weights of the policy 1 and policy 2 scenarios. The ULaval SW tool calculated an interval of stability for each result in relation to the weights, the veto thresholds and the cutting level.

A synthesis of the stability analysis and its results is presented in Table 8, where the values that indicate a not so robust result are in bold. The result, in relation to the balanced weights, is almost stable. The stability is less evident in relation to the Policy 1 scenario and is absent in relation to Policy 2. The model results, in relation to the veto thresholds, are always almost stable, with the exception of the Urbanization criterion and (sometimes) of the Territorial desirability criterion. The results pertaining to the cutting level were not stable and their behaviour was therefore analysed.

Sixteen tests were activated, in relation to the studied parameters, and the results were synthesized and analysed to verify the model robustness (Table 9): the balanced weights plus $v_2=1.25$, or plus $v_6=9$, or $\lambda=0.66$, or $v_2=1.25$, $v_6=9$ and $\lambda=0.66$; the Policy 1 weights plus $v_2=1.26$, or $\lambda=0.66$, or $v_2=1.26$ and $\lambda=0.66$; the Policy 2 weights plus $v_2=1.23$, or $v_6=9.5$, $\lambda=0.66$, or $v_2=1.23$, $v_6=9.5$ and $\lambda=0.66$; the Policy 1 new weights: CO2 Emissions (0.171), Urbanization (0.181), Environmental Awareness (0.198), Progress in Social Life (0.198), Reaction Time (0.122), Territory Desirability (0.128); the Policy 2 new weights (1): CO2 Emissions (0.151), Urbanization (0.151), Environmental Awareness (0.151), Progress in Social Life (0.151), Reaction Time (0.195), Territory Desirability (0.201); the Policy 2 new weights (2): CO2 Emissions (0.148), Urbanization (0.148), Environmental Awareness (0.148), Progress in Social Life (0.148), Reaction Time (0.203), Territory Desirability (0.201).

Table 8: Synthesis of the robustness analysis results

		Balanced weight	Policy 1	Policy 2
CO2 Emissions	Weight	[0.1314, 0.1908]	[0.1392, 0.1701]	[0.1499 , 0.1501]
	$v_1=5$	[3, 6]	[4, 6]	[4, 6]
Urbanization	Weight	[0.1414, 0.1854]	[0.1339, 0.1800]	[0.1499 , 0.1501]
	$v_2=1.2$	[0.78, 1.24]	[0.36, 1.25]	[0.73, 1.22]
Environmental Awareness	Weight	[0.1414, 0.1854]	[0.1999 , 0.2308]	[0.1499 , 0.1501]
	$v_3=25$	[15.98, +∞]	[14.95, 28.81]	[15.54, +∞]
Progress in Social Life	Weight	[0.1314, 0.1908]	[0.1999 , 0.2308]	[0.1499 , 0.1501]
	No veto			
Reaction Time	Weight	[0.1414, 0.4450]	[0.1199, 0.1771]	[0.1999 , 0.3250]
	$v_5=0.19$	[0.04, +∞]	[0.04, +∞]	[0.04, +∞]
Territorial Desirability	Weight	[0.1414, 0.1854]	[0.1299 , 0.1608]	[0.0577, 0.2000]
	$v_6=10$	[9.43 , 10.98]	[8.98, 10.62]	[9.79 , 11.30]
Cutting Level		[0.51004636, 0.6599487]	[0.63001096, 0.650061]	[0.566687, 0.650061]

A robustness analysis of a result, activated at the end of a decision aid intervention, should also test all the combinations of the critical values of the other parameters and evaluations, in order to verify the robustness of the conclusion (Roy, 1998; Roy and Bouyssou, 1993). However, different policy scenarios are not analysed very often. In this case, the robustness analysis was different and specifically oriented towards verifying the robustness of the model.

The synthesis in Table 9 presents the same final judgement as Table 7, with the exception of SOVIC, which passed from I/G to G, and TREQU, which passed from strange to strange but oriented towards B.

Table 9: Results of the robustness analysis

Classes Municipalities	Good - Good	Intermediate - Good	Intermediate - Intermediate	Bad - Good	Bad - Intermediate	Bad - Bad	Whole judgment
RADICOFANI (RADI)			16				I
SARTEANO (SARTE)					5	11	B
PIENZA (PIENZ)			1	4	11		S → B
SAN QUIRICO D'ORCIA (SANQ)		8		8			S → G
CASTIGLION D'ORCIA (CASTI)				3	13		S → B
MANTALCINO (MONTA)		5	11				IG
MURLO (MURLO)		4	12				IG
BUONCONVENTO (BUONC)		4	4		8		S
SAN GIOVANNI D'ASSO (SANGI)					16		B
TREQUANDA (TREQU)			12	3	1		S → B
ASCIANO (ASCIA)			16				I
MONTERONI D'ARBIA (MONTE)		8		8			S → G
RAPOLANO TERME (RAPOL)			16				I
CASTELNUOVO BERARDENGA (CASTE)	8	8					G
GAIOLE IN CHIANTI (GAIOL)	8		8				G
RADDA IN CHIANTI (RADDA)	12	4					G
MONTERIGGIONI (MONGG)	11		5				G
SOVICILLE (SOVIC)	8		8				G
RADICONDOLI (RADIC)					5	11	B
CHIUSDINO (CHIUS)		16					I/G
MONTICIANO (MONTI)				3	13		S → B

Only for BUONC was it impossible to assign a clear and robust category. BUONC was analysed and was found to be a fascinating small Italian town (3137 inhabitants), dating back to the Middle Ages, that is surrounded by defence walls. Buonconvento is the only municipality in the Ombrone basin that is included in the Association of the best Italian "borghi-boroughs" (<http://borghiubiubelliditalia.it>). The obtained result suggested that a model cannot easily evaluate the resilience of such a specific and almost unique town.

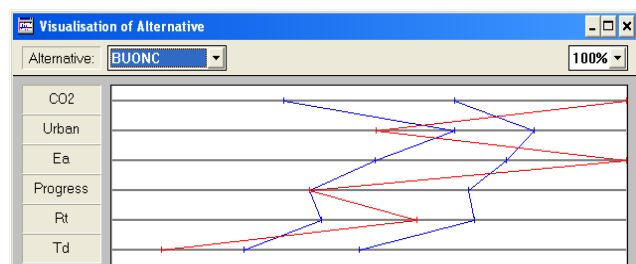


Figure 8 – Visualisation of Buonconvento.

Conclusions

The application of an ELECTRE method to a model, which has to be developed without decision makers in the ambit of a SISTI approach, can be considered a study on how the uncertainty of an output can be connected to different sources of uncertainty in the model structure, evaluations and parameters, which are the inputs of the ELECTRE application. Some alternative assumptions on the choice of the parameters (or on the model structure and its evaluations), which could generate uncertainty or criticalities in the results, should be tested to determine their impact on the results, and then used to increase the understanding of the expected and unexpected relationships between the model and results of an ELECTRE application.

In this SISTI application, the input draft model was the result of previous SISTI cycles, which improved the model structure and some parameters, but considered a clear ranking impossible, and therefore proposed a change in the problem statement from classification to sorting.

ELECTRE Tri was then applied to the draft model, and some SISTI cycles led to an improvement in the model. Eventually, a robustness analysis was activated to test the flexibility of the model, in relation to possible future policies, and the stability of the result, in relation to the decision parameters. The final model and its use, in relation to a sorting problem statement, were considered robust enough to be proposed to the actors who had perceived the decision problem, together with the evidence that a sorting approach may often be more useful than a ranking.

SW tools played an important role in this learning process, by facilitating the visualization of the impact on the results that were generated by each choice of parameter or modelling scenario. An SW tool should be able to facilitate the sensitivity and robustness analyses and to visualize the evolution of the results during the modelling process. In this case, only one SW tool was not able to facilitate the activities of the SISTI cycles, but an integration of two SW tools allowed the modelling process to be developed and concluded.

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MCDA Research Groups

MCDA and sustainability assessment at Politecnico di Torino

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The research group on "MCDA and sustainability assessment" works at the Department of Urban and Regional Studies and Planning of the Politecnico di Torino (Italy) in the general scientific domain of Project Appraisal and Planning Evaluation. The group is composed by professor Marta Bottero and Professor Giulio Mondini. Five Ph.D. students and several Master students are currently supervised and co-supervised by the members of the group.

The work of the group is mostly devoted to the application of multicriteria methods to real-world case studies of urban and territorial transformations, making use of different techniques and approaches. The fundamental characteristics of the research carried on by the group are the presence of different dimensions that have to be taken into account in the evaluation, including socio-economic, ecological, technical and cultural factors, and the interaction with different stakeholders and Decision Makers who play a role in the urban and territorial systems.

Within this research framework, the main areas of investigation are:

- Urban regeneration and energy requalification;
- Smart and resilient cities;
- Environmental Impact Assessment and Strategic Environmental Assessment;
- Urban Management;

- Ecosystem services and ecological/economic indicators;
- Landscape and cultural heritage.

Many MCDA methods have been considered by the research group over the years, including ELECTRE III, PROMETHEE, NAIADE, Multi Attribute Value Theory (MAVT), SMARTER, Dominance-based Rough Set Approach (DRSA), Multicriteria – Spatial Decision Support System (MC-SDSS), Choquet integral, Non Additive Robust Ordinal Regression (NAROR).

Among the different research activities, of particular importance is the examination of the interactions between criteria in decision problems in the context of sustainable development. In this domain, it is worth mentioning the collaboration with Professor Bernard Roy (LAMSADE, Paris), Professor José Rui Figueira (University of Lisbon), Professor Salvatore Greco (University of Catania) and Professor Valentina Ferretti (Politecnico di Milano) for investigating the use of ELECTRE III method and Choquet integral for supporting environmental decision-making processes.

Another relevant line of research developed by the group is related to the exploration of multi-methodological approaches which are based on the integration of different methods using both qualitative and quantitative data. In this field, the activities focus on the experimentation of different research designs combining several evaluation methods, such as SWOT analysis, Stakeholders Analysis and different MCDA techniques, to overcome weaknesses of the specific methods and exploit strategically the synergies resulting for their integration.

Further promising lines of activity of the group are related to the application of the Spatial Multicriteria Analysis. The analysis, which is based on the integration of Multicriteria Analysis with GIS (Geographic Information System), helps to design territorial transformation scenarios and to visualize the results of the evaluation, thus allowing the participation of the stakeholders to the decision process and the communication of the outcomes of the model to the Decision Makers.

Recent developments of the research work also includes the exploration of the method ELECTRE TRI-nc in collaboration with professors Jose Figueira and Salvatore Greco, Dr. Grazia Napoli (University of Palermo) and Federico Dell'Anna (Politecnico di Torino) for supporting the allocation of economic resources in decision problems regarding energy retrofit operations in public buildings.

Another recent research development is related to the application of the GAHP II Sorting method in collaboration with professor Alessio Ishizaka and Menelaos Tasiou (University of Portsmouth) and Vanessa Assumma (Politecnico di Torino) for classifying different municipalities in the Piedmont Region (Italy) with reference to their attractiveness in terms of Landscape Economic Value taking into account the opinions of a panel of experts.

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About the 88th Meeting of the EWG/MCDA

Instituto Superior Técnico-ULisboa and the research centers INESC-ID, IN+, CERIS and CEG-IST were honoured for had hosting the 88th Meeting of the EWG-MCDA. This meeting was held on September 27th-29th, 2018, in the Academy of Sciences of Lisbon, Lisbon, Portugal. The main topic of the meeting was "MCDA user-friendly software for performance assessment for Smart Cities". Scholars and practitioners were invited to contribute papers to discuss theoretical, methodological, and application studies dealing with multiple criteria decision aiding, and in particular, those related to the topic of the meeting. The interest in the Meeting was outstanding. The organizers received 60 submissions. More than 90 participants from 17 countries (including from non-European countries, as Australia, Brazil, Canada, Morocco, and Japan) attended the meeting.

The meeting allowed experienced researchers as well as young PhD students to present and discuss their works in memorably good conditions. The participants appreciated very much the warm welcome at the Academy of Sciences of Lisbon during the opening session, as well as splendid interiors and facilities available for the meeting. All this contributed to valuable scientific exchanges during the sessions and during the breaks. Participation of researchers from so many countries permits to claim that the meeting was extremely important for promoting and developing MCDA methodology not only in Portugal but also worldwide.

In the first day, the meeting started on midday with a welcome lunch. The inaugural sessions started with José Rui Figueira opening the meeting and welcoming the participants. The session continued with the welcome to the Academy by its President, Professor Artur Anselmo, and Vice-President, Professor Carlos Salema. After, the President of the Instituto Superior Técnico (IST), Professor Arlindo Oliveira, welcomed the participants on behalf of IST-ULisboa. The President of APDIO (The Portuguese Society for the Development of Operational Research), Professor José Fernando Oliveira, welcomed the participants and mentioned in his talk the importance of MCDA for the development of Operational Research in Portugal and for its special role within APDIO (which was also a special sponsor of the Meeting). Finally, Professor Roman Slowinski welcomed the participants on behalf of the co-coordinators of the EWG-MCDA. The day continued with a special session in which a talk in honour of the group founder, Professor Bernard Roy, was presented by José Rui Figueira, Roman Slowinski and Salvatore Greco. This was a moment of a great emotion for all the participants who wished to pay a tribute to the person who gave so fundamental and outstanding contribution to the field of MCDA and OR, whose relevance goes beyond the European context assuming a

special significance at the world level. In the next session there was the very plenary talk delivered by Professor Luís Valadares-Tavares, who also was of a great help and substantially contributed to the organization of this meeting. The day concluded with a banquet at the historical district of Graça in a restaurant called Via Graça with a fantastic view on the Tagus River and some other old districts of the town of Lisbon. During the banquet, the participants had the pleasure to see and hear the sound of classical Portuguese guitar and the Fado with the extraordinary voice of Dona Alice Nunes and her musicians, in the Portuguese guitar Arménio de Melo and in the classic guitar, Francisco do Carmo. The banquet gave also an opportunity for networking by old and new members of the community.

The second day started early morning and ran two consecutive sessions of presentations. As in the first day, the lunch was served in the Academy with a nice atmosphere rendering possible the participants to talk and promote exchange. In the afternoon, after the usual session devoted to the life of the group, two other sessions took place. After the sessions the participants had free time for visiting Lisbon.

On the third day, the participants went by bus to the picturesque village of Sintra, near Lisbon, with a professional and well documented guide and enjoyed a guided tour of some tourist highlights, before, during, after the Sintra town. After visiting Sintra, the participants had a lunch meal at a typical Portuguese restaurant nearby, and later followed the Coastal area through Guincho, Cascais, marginal, and Belem before reaching downtown Lisbon.

This meeting would not have been successful without the contribution and support of all participants, keynote speakers, session chairs, collaborators, and also the organizing and scientific committee. Sincere gratitude goes to all of them for the high-quality papers, presentations, and discussions not to mention their valuable time and active participation throughout the meeting.

The above permits to hope that all participants had a fruitful and insightful conference and a wonderful stay in Lisbon. The next meeting will take place in Trento within six months.

Lisbon, October 28th, 2018

José Rui Figueira (Chair)

José Luís Borbinha

Carlos Santos Silva

Rui Cunha Marques

PROGRAM

Thursday, 27TH

11:00-12:00 Registration - Main Hall of the Academy of Sciences of Lisbon

12:00-13:00 Light lunch - Cloisters of the Academy building

13:00-13:30 *Opening session* Room: Salão Nobre
Prof. Artur Anselmo (President of the Academy of Sciences of Lisbon)
Prof. Arlindo Oliveira (President of IST-ULisboa)
Prof. José Fernando Oliveira (President of APDIO)
Prof. José Rui Figueira (Program Chair)

13:30-15:00 *Special session* Room: Salão Nobre.
Chair: Manuel Matos

– T1: "Bernard Roy and the EWG-MCDA"
Roman Słowiński, Salvatore Greco, José Rui Figueira

– T2: "Sustainable Cities: New challenges for MCDA applications"
Carlos Santos Silva, Joana Pedro, Manuel Pinheiro

– T3: "DECSPACE: A user-friendly web-based platform to explore MCDA methods"
Ana Sara Costa, João Amador, Rúben Rodrigues, José Rui Figueira, José Borbinha

15:00-16:00 *Plenary lecture* Room: Salão Nobre
Chair: Carlos Henggeler Antunes

T4: "The digital challenges: From decision support systems to contracting support systems"
Luís Valadares Tavares

16:00-16:30 Coffee-break - Second Floor of Academy building

16:30-18:30 *Session 1* Room: Salão Nobre
Title: Multi-objective models for Smart Cities subsystems
Chair: Masahiro Inuiguchi

– T5: "A bi-objective mixed integer linear programming model to optimize demand response in face of dynamic tariffs"
Inês Soares, Maria João Alves, Carlos Henggeler Antunes

– T6: "Selection of Best Normalization Techniques for MCDM methods"
Nazanin Vafaei, Rita A. Ribeiro, Luis M. Camarinha-Matos

– T7: "Optimization and multicriteria evaluation of renewable district heat"
Elnaz Abdollahi, Genku Kayo, Risto Lahdelma, Pekka Salminen

– T8: "Multiobjective Models for Planning Problems"

Maria Barbati, Salvatore Corrente, Salvatore Greco
Papers submitted to discussion:

– PSD1: "Sustainable Supply Chain Network Design: An application to the wine industry in southern Portugal"

Rui Fragoso, José Rui Figueira, Ana Carvalho

– PSD2: "Objective Functions and Fitness Landscapes in the Smart Grid for Deferrable Loads Optimizing Grid Stability"

Tuncer Haslak

– PSD3: "A multiobjective model for managing disaster relief operations' response teams"

Mário Simões Marques, José Rui Figueira

– PSD4: "The robustness of portfolio efficient frontiers: A comparative analysis of bi-objective and multi-objective approaches"

Antonis Pavlou, Michalis Doumpos, Constantin Zopounidis

20:00 Banquet Typical Lisbon Restaurant (downtown Lisbon)

Friday, 28TH

9:30-11:00 *Session 2* Room: Sala das Sessões
Title: Energy and urban MCDA models for Smart subsystems
Chair: Maria Franca Norese

– T9: "Multicriteria approach to the expansion of an electric generation system"
Leonel Carvalho, Pedro Barbeiro, Manuel Matos

– T10: "A novel modelling approach to support end-use energy efficiency policy design – the case-study of India"

Vivek K. Singh, Carla Oliveira Henriques, António Gomes Martins

– T11: "Decision making in complex urban contexts: An application for a critical area in the city of Torino (Italy)"

Vanessa Assumma, Mauro Berta, Marta Bottero, Caterina Caprioli

Papers submitted to discussion:

– PSD5: "How to support DMs in the context of urban development processes. Using the Choquet integral for evaluating design alternatives: A case study"

Alessandra Oppio, Marta Dell'Ovo, José Rui Figueira

– PSD6: "Prioritization of Policy Instruments in Buildings Energy Retrofit"

Chiara D'Alpaos, Paolo Bragolusi

- PSD7: "The application of the ELECTRE TRI-nC to a multiple criteria decision aid model for sorting alternative energy retrofitting measures"
Marta Bottero, Federico ell'Anna, José Rui Figueira, Salvatore Greco, Grazia Napoli
- PSD8: "Methodological approach for a group decision-making in a spatial decision problem"
A. Mendas, A. Mebrek, Z. Mekranfar, Z. Saadouni
- 11:00-11:30 Coffee break Second Floor of of the Academy building
- 11:30-13:00 *Session 3* Room: Sala das Sessões
Title: On the theory of MCDA
Chair: Constantin Zopounidis
- T12: "Multiobjective knapsack optimization by an interactive evolutionary algorithm with rule preference model: the IEMO-DRSA Method"
Salvatore Corrente, Salvatore Greco, Benedetto Matarazzo, Roman Słowiński
- T13: "Variants and extensions of Arrow's impossibility theorem: An algebraic approach"
Miguel Couceiro, Gerasimos C. Meletiou
- T14: "Evidence theoretic view of interval AHP"
Masahiro Inuiguchi
Papers submitted to discussion:
- PSD9: "PRIC-DEA: Preference information incorporation using the Choquet integral in a DEA model"
Miguel Pereira, José Rui Figueira, Rui Cunha Marques
- PSD10: "Application of a novel PROMETHEE-based method for construction of a group compromise ranking to prioritization of green suppliers in food supply chain"
Miłosz Kadziński, Kannan Govindan, R. Sivakumar
- PSD11: "A framework for conflict analysis in Evidence Theory integrating different conflict measures"
Adiel de Almeida-Filho, Lucimário Gois, Roman Słowiński, Salvatore Greco
- PSD12: "An MCDA methodology to analyse hypotheses of adaptive reuse for an iconic historical building"
Francesca Abastante, Salvatore Corrente, Salvatore Greco, Isabella M. Lami, Beatrice Mecca
- 13:00-14:30 Lunch Antechamber of the Sessions
Room (Antecâmara Sala da Sessões)
- 14:30-15:00 *Regular session* Room: Sessions Room
Life of the group
Chair: Roman Słowiński
- 15:00-16:30 *Session 4* Room: Sala das Sessões

Title: MCDA Applications I
Chair: Luís M.C. Dias

- T15: "A multicriteria approach for risk evaluation and classification of activities in a drinking water source watershed: A case study in Quebec City (Canada)"
Ariane Marais, Irène Abi-Zeid, Manuel J. Rodriguez
- T_16: "Multiple Criteria Decision Aiding method to assess vine production systems performances concerning pesticides and health near Bordeaux metropole"
Nawel Aouadi, Francis Macary
- T17: "Retour d'expérience sur la réalisation et la pratique d'un MOOC en Aide MultiCritère à la Décision"
Vincent Clivillé, Maux Vicente De Oliva, Jaime Manera y Bassa
Papers submitted to discussion:
- PSD13: "Ranking of Spanish Smart Destinations with TOPSIS"
Amelia Bilbao-Terol, Mar Arenas-Parra, Celia Bilbao-Terol, Verónica Cañal Fernández
- PSD14: "Planning the future health workforce"
Diana F. Lopes, Eduardo A. Castro, Jorge A. Simões
- PSD15: "Non-dominated sorting genetic algorithm-II applied to multiobjective environmentally-friendly single-barge loading problem with weight distribution limitation"
Amina El Yaagoubi, Ahmed Elhilali Alaoui, Jaouad Boukachour
- PSD16: "A composite indicator for analyzing the entrepreneurship environment in Europe: A goal programming approach"
António M.S. Xavier
- PSD17: "Integrating time into majority-rule sorting models: application to the cyber-defense context"
Arthur Valko, David Brosset, Patrick Meyer
- PSD18: "Using multi-criteria decision sorting and DEA to analyze Brazilian economic sectors"
Edlaine C. S. Martins, Elaine C.B. de Oliveira, J. Pereira, Danielle C. Morais
- PSD19: "AGENDA 2030: Would it be possible to reach the sustainable development objectives? A multicriteria and econometric analysis"
G.M. Fernández Barberis, M.C. Escribano Ródenas, M.C. García Centeno
- PSD20: "The MCDA approach to public policy benchmarking"
Mladen Stamenković, Marko Backović

- PSD21: "Model for the determination of weights useful to MCDA applied in Moroccan pension funds"
adreddine El Goumi, Mohammed El Khomssi, Amine Jamali Alaoui
- PSD22: "Multiple criteria decision aiding model for an innovative eco-design of a product, within a responsible company"
Fatima El Khoukhi, Ahmed El Hilali Alaoui, Jaouad Boukachour
- 16:30-17:00 Coffee break Antechamber of Sessions Room (Antecâmara da Sala das Sessões)
- 17:00-18:30 *Session 5* Room: Sala das Sessões
Title: MCDA Applications II
Chair: Risto Lahdelma
- T18: "Incremental preference elicitation for SRMP models: Application for autonomous drones"
Arwa Khannoussi, Alexandru-Liviu Olteanu, Catherine Dezan, Jean-Philippe Diguët, Patrick Meyer
- T19: "How to assess urban quality: A spatial multicriteria decision analysis approach"
Marta Dell'Ovo, Alessandra Oppio
- T20: "A first contribution of multicriteria clustering with capacity constraints"
Jean Rosenfeld, Dimitri Van Assche, Yves De Smet
Papers submitted to discussion:
- PSD23: "Primitives of decision aiding"
Alexis Tsoukiàs
- PSD24: "Some new tools to visualize MCDA problems"
Gilles Dejaegers, Jean-Philippe Hubinont, Yves De Smet
- PSD25: "MCDA framework based on MAUT and WAP methods for evaluating agricultural management schemes"
A. Psomas, I. Vryzidis, A. Spyridakos, M. Mimikou
- PSD26: "Status quo effect within PROMETHEE in the case of municipal companies operating in Cracow, Poland"
Elżbieta Kubińska, Magdalena Łojewska, Mariusz Andrzejewski, Jakub Bator, Stelios Rozakis
- PSD27: "Supply chain network design using interactive decision maps"
Rui Fragoso, Vladimir Bushenkov
- PSD28: "Scheduling program proposal for an emergency department in case of disasters"
Salma Makboul, Ahmed El Hilali Alaoui, Ghizlane Bencheikh
- PSD29: "A multiple criteria decision aiding approach to prioritize and to select tangible urban cultural heritage projects"
Maria Barbati, José Rui Figueira, Salvatore Greco, Alessio Ishizaka, Simona Panaro
- PSD30: "Modelling the touristic place anti-commons with MCDM methods"
José António Filipe, Tolga Genç, Mehmet Kabak
- PSD31: "Clustering for multicriteria satisfaction análisis"
Konstantina G. Miteloudi, Alkaios Sakellaris, Evangelos Grigoroudis, Nikolaos Matsatsinis
- PSD32: "A framework for a multicriteria business site selection based on diversity of data sources"
Alkaios Sakellaris, Konstantina G. Miteloudi, Nikolaos Matsatsinis
- PSD33: "DSS in small-scale farming"
H. Papadopoulos, Z. Nivolianitou
- PSD34: "Méthode d'Aide à la Décision Multicritère dans le contexte de gestion de crise dans le transport aérien"
Hassane Yamnahakki, Abdellah Menou
- PSD35: "Better together: Preference disaggregation at group level improves predictive accuracy at individual level"
Mohammad Ghaderi, Nuria Agell, Miłosz Kadzinski
- PSD36: "A multi-criteria analysis of bullwhip effect in closed-loop supply chains under uncertain refurbishing processing times"
Roberto Dominguez, Salvatore Cannella, Jose M. Framinan
- PSD37 "Multi-objective surgery scheduling integrating real-life surgeon constraints: A case study"
Marwa Khalfalli, Fouad Ben AbdelAziz Hichem Kamoun
- 18:30-18:45 *Closing session* Room: Sala das Sessões
- Saturday, 29TH
- Excursion

Summer School

EURO PhD Summer School on MCDA/M 2018 23 July – 3 August 2018 Chania, Greece

The 13th MCDA/M Summer School was held in Chania, Greece from July 23 to August 4, 2018. This edition of the Summer School continued the tradition of the previous 12 events organized by the International MCDM Society and the EURO Working Group on Multicriteria Decision Aiding. The first event was organized in 1983, at Catania-Italy by Benedetto Matarazzo and the latest edition was organized in 2016 at Recife-Brazil, by Danielle Costa Morais and Luciana Hazin Alencar.

The event of this year was further supported by the Association of European Operational Research Societies (EURO), thus being organized as the 2018 EURO PhD Summer School on MCDA/M.

The Summer School was organized by the Technical University of Crete in cooperation with the Mediterranean Agronomic Institute of Chania (MAICH) and was held at the Conference Center of MAICH. The Summer School was co-Chaired by Constantin Zopounidis and Michalis Doumpos (Technical University of Crete, Greece).

The MCDA/M Summer Schools provide participants with a unique opportunity to get a comprehensive and in-depth view of the state-of-the-art in MCDA/M approaches and methodologies, their applications in various areas, the relevant software decision support tools, and the interconnections of MCDA/M with other closely related theoretical and applied disciplines from OR/MS, computer science, engineering, and social sciences. Moreover, the Summer Schools provide a forum through which PhD students exchange knowledge, ideas and experiences, discussed open problems, obtained feedback from leading scholars in MCDA/M, and built fruitful collaborations, which strengthen the MCDA/M community and support its future progress.

Building on this philosophy, the 13th Summer School provided a detailed coverage of all established and emerging areas in MCDA/M, the new theoretical developments, software tools, and application areas.

In accordance with previous summer schools on MCDA/M, a target of approximately 50 participants was set. Ultimately, 52 students from 18 countries were chosen by the Organizing Committee out of 62 candidates who submitted their application by the given deadline. Approximately 15 more participants showed late interest in attending the EPS-MCDA/M, but these cases were not considered, because all positions have already been filled. Following the guidelines of EURO, only applications by PhD students were considered, with priority given to applicants from EURO member society countries. In the final selection, 46 out of the 52 candidates were from EURO member society countries. The remaining participants were from Brazil, Canada, and Mexico. All

participants received a certificate of completion stating the ECTS credits accomplished.

The academic program of the school consisted of a combination of theoretical classes and case work. The theoretical lectures covered all the main theoretical advances in MCDA/M and their applications. Overall, the program included 26 theoretical lectures for a total of 39 hours (90 minutes each lecture). The lectures were delivered by well-known scholars in the field:

- Adiel Teixeira de Almeida (Universidade Federal de Pernambuco, Brazil)
- Michalis Doumpos (Technical University of Crete, Greece)
- Matthias Ehrgott (Lancaster University, UK)
- Jose Figueira (Technical University of Lisbon, Portugal)
- Salvatore Greco (University of Catania, Italy & University of Portsmouth, UK)
- Evangelos Grigoroudis (Technical University of Crete, Greece)
- Miłosz Kadziński (Poznan University of Technology, Poland)
- Murat Köksalan (Middle East Technical University, Turkey)
- Kaisa Miettinen (University of Jyväskylä, Finland)
- Yannis Siskos (University of Piraeus, Greece)
- Eleftherios Siskos (National Technical University of Athens, Greece)
- Roman Słowiński, Poznan University of Technology, Poland
- Alexis Tsoukias (Université Paris Dauphine, France)
- Jyrki Wallenius (Aalto University, Finland)





The topics covered in the academic program included decision modeling, multi-attribute utility/value theory, interactive methods, outranking approaches, rule-based methods, UTA methods, group decision making, MCDA software, robustness analysis, robust ordinal regression, multi-objective combinatorial optimization, nonlinear multi-objective optimization, behavioral aspects, as well as applications in customer satisfaction and finance. The full program of the Summer School is available at <http://www.mcda-school18.tuc.gr/program.htm>

All lectures were thought-provoking, attractively presented, well-attended and highly appreciated by the students, who had an active participation in the lectures and interacted with the instructors.

In addition to the theoretical classes, the program also included a lecture by the President of the International MCDM Society, Murat Köksalan, that introduced the students to the MCDA/M community and its activities, as well as a lecture that provided the students with valuable information about the preparation of research publications, which is important for PhD students who are at their first steps of their research career. The lecture was given by Roman Słowiński, the coordinating Editor-in-Chief of EJOR.



Most of the afternoon sessions focused on case work. A case study was prepared involving the multicriteria evaluation of the sustainability of cities. The case project was introduced to the students in the first day of the school by Evangelos Grigoroudis and Michalis Doumpos, who also acted as tutors for the students' work on the case study.



Students were organized into 7 groups. The groups were formed considering the background and research interests of the students, with emphasis given to form diversified

groups and promote the exchange of different ideas and knowledge among students.

The groups applied different MCDA/M methodologies. Throughout the two weeks of the Summer School, the program included case work sessions (9 sessions), during which the student groups worked independently. The tutors and the instructors were also present and provided constructive feedback to the students and responded to questions regarding the handling of the case project and the application of MCDA/M methodologies.

On the last day of the Summer School each student group provided an open presentation of their work. The presentations were all high quality, reflecting the enthusiastic and hard work devoted by the students during the two weeks of the Summer School. The presentations and the results of the groups were evaluated by the Organizing Committee, who also provided constructive feedback and suggestions for future research. Moreover, three student groups received a special acknowledgment for the quality of their case project work.



Besides the academic program, a social program was included to strengthen ties between the participants to establish a future network. The events organized during the Summer School included a social dinner and an excursion.

The social dinner was held on the evening of Saturday 28th at the Mediterranean Agronomic Institute of Chania, whereas the excursion was organized on the afternoon of August 1st. The excursion included a visit at Venizelos Tombs (Eleftherios Venizelos, 1864-1936, was one of the

most prominent Greek politicians who served seven times Prime Minister of Greece) and the traditional village of Stavros, a popular destination in Chania, known for its amazing beach where the scene with Anthony Quinn dancing Greek sirtaki was filmed for the well-known movie "Zorba the Greek".



Overall, we feel that the 2018 EURO PhD Summer School on MCDA/M has succeeded its goals, bringing together young researchers who demonstrated an enthusiastic interest in MCDA/M and will contribute in promoting and advancing the field in the upcoming years. The academic and social program were highly appreciated by all participants (students and instructors), who also had free time to explore the beauties of Chania and the surrounding area.

The successful organization of such a challenging event would not have been possible without the support from the staff of the Conference Center of MAICH. Special thanks go to EURO for its generous support and the International MCDM Society for providing financial support to students from developing countries. Moreover, we should express our sincere gratitude to Evangelos Grigoroudis and Yannis Siskos for their active involvement as tutors for the case project as well as to all instructors who accepted to provide lectures at the Summer School and played a crucial role to the success of the academic program.

We are looking forward to seeing you all again next year, at the 25th International Conference on Multiple Criteria Decision Making, in Istanbul, Turkey!

Constantin Zopounidis, Michalis Doumpos

Software

Criteria Weights Assessment through Prioritizations (WAP) software tool

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Summary

A software tool developed for supporting the implementation of WAP (criteria Weights Assessment through Prioritizations) method is presented in this short article. WAP method has been proposed as an approach for supporting the process of estimating in MCDA problems the criteria importance weights in a more robust manner. Methods that ask the decision maker (DM) to construct a hierarchy on the evaluation criteria, such as Simos method with cards, may result in infinite number of optimal solutions bordered into a hyper-polyhedron. In order for the decision support process to be continued a representative average weighting vector (barycenter) of all different solutions is selected. However, in several cases the feasible weighting space is very big, so the set of the optimal weighting vectors is characterized by low robustness, meaning that they will cause significant ranking variations when applied to the decision problem. Furthermore, when low robustness is apparent the average weighting vector cannot always be considered satisfactory as far as the representation of the DM's preferences is concerned.

WAP method includes several robustness rules such as the computation of the variation range of the weight of each one of the n criteria, visualization of the ranges of variation of the criteria weights and computation of the robustness measure ASI. Additionally to the aforementioned rules, the WAP method includes a process for receiving additional information from the DM concerning the difference between the weights of the criteria. The key point of the WAP method is the use of the z_r indices for every pair of successive criteria or sets of ex aequo criteria sorted, based on the DM's ranking.

Robustness Concern in Criteria Weights Inference

In order to assess the criteria importance weights for non-compensatory MCDA models like the outranking methods (ELECTRE, PROMETHEE, ...) or for some multiobjective optimization methods (goal programming,

compromise programming), two kinds of methods are used:

- direct assessment procedures, where the DM is asked to explicitly express the criteria weights in terms of percentages, and
- indirect methods aiming to infer the weights from pairwise comparisons of the criteria or reference alternatives. (eg. Simos Cards Method).

Focusing on Simos method (Simos, 1990a; Simos, 1990b), it has gained popularity and has been applied to different types of problems due to its simplicity and convenience to extract the DM's preferences. It requires building a hierarchy on the evaluation criteria, by involving the DM to a "playing cards" procedure, in order to attribute numerical values to them. Briefly the original Simos method consists of the following three steps concerning the interaction with the DM: (1) The DM is given a set of cards with criterion name on it, along with a set of white cards with the same size. (2) The DM gives a complete pre-order on the whole of the n criteria by ranking these cards from the least important to the most important. If some criteria have the same importance (i.e., the same weight), DM should build a subset of cards holding them together with a clip. (3) DM is asked to introduce white cards in between of two successive subsets of criteria for increasing the difference of importance of criteria. The greater the difference between the mentioned weights of the criteria (or the subsets), the greater the number of white cards.

The information provided by the DM is utilized by the Simos method for the determination of the weights, according to the following algorithm:

- i. ranking of the subsets of ex aequo from the least important to the most important, considering also the white cards,
- ii. assignment of a position to each criterion/card and to each white card,
- iii. calculation of the non-normalized weights, and
- iv. determination of the normalized weights.

In their effort to address some robustness issues, Figueira and Roy (2002) proposed a revised version of the Simos method. In addition to the above three-step data collection process the new procedure introduces a fourth step by asking the DM to state "*how many times the last criterion is more important than the first one in the ranking*" (ratio z). This ratio is used in order to define a fixed interval between the weights of criteria or their sub-sets. Let u denotes this interval: $u = (z-1)/e$, where e is the number of different weight classes (meaning: single card, subsets of cards, and white card).

The main advantages of Simos method is its simplicity, which makes it convenient for the DM to express his/her preference, and also the easiness of the necessary calculations. On the other side, serious questions have been raised concerning robustness issues focusing on the point that a unique weighting vector is arbitrarily

calculated even though infinite number of weight vectors may exist, also satisfying DM's preferential statements.

The Simos method, exhibiting considerably easy, almost naïve, data collection and implementation, has been extensively used in the scientific literature. Several authors have made use of the method, mostly combined with ELECTRE type methods, in order to assess the importance of the criteria weights. A review of the literature in Siskos and Tsotsolas (2015) unveiled a very wide area of application, from energy planning and environmental evaluation problems, to project selection and mechanical engineering problems. It is recognized that Figueira and Roy triggered a wide application of the Simos methodology, since in most of the published studies their revised version has been applied. However, the majority of papers use Simos for simplicity and convenience reasons, without examining or analyzing its robustness risks. Rarely the robustness of the results is investigated, or the stability of the weights obtained by Simos is examined. For example Shaniyan et al. (2008) partially examined the impact of the parameter "z", on the final results.

The preference model of the DM, as expressed in Simos method, can be described using the following LP model:

Having a family of n criteria g_1, g_2, \dots, g_n , rearranged in such a way that g_j is less or equally important than g_{j+1} for every $j=1, 2, \dots, n-1$, according to steps 1-2 of the Simos procedure, for every $j = 1, 2, \dots, n-1$, and $h = 1, 2, \dots, k$, where n is the number of criteria and k the number of white cards with ($k < n$) we have:

- If g_j is followed by g_{j+1} , and g_{j+1} belongs to the same importance class as g_j , write:

$$p_j = p_{j+1}$$

- If g_j is followed by g_{j+1} , and g_{j+1} belongs to a most importance class, write:

$$p_j < p_{j+1} \Leftrightarrow p_{j+1} - p_j \geq \delta$$

- If between g_j and g_{j+1} a white card w_h is placed, write:

$$p_j < w_h \text{ and } w_h < p_{j+1} \Leftrightarrow w_h - p_j \geq \delta \text{ and } p_{j+1} - w_h \geq \delta$$

- $p_1 + p_2 + \dots + p_n = p_1 \geq 0, p_2 \geq 0, \dots, p_n \geq 0; w_1 \geq 0, w_2 \geq 0, \dots, w_k \geq 0$

- In case of the revised Simos method, the following equation should be added:

$$p_n = zp_1$$

So, all the Simos weighting solutions belong to the polyhedral set:

$P = \{ \mathbf{p} \in R^n / \mathbf{p}$ satisfies the system of these linear relations

In Siskos and Tsotsolas (2015) it has been proved that the polyhedral set P either contains a single criteria weighting vector, or an infinite number of weighting vectors that are all consistent with the DM's criteria ranking. However, the case of a single criteria weighting vector corresponds only to two specific cases, while in the majority of real world problems there exists an infinite number of weighting vectors that are consistent with the DM's ranking and form a (hyper-polyhedron P). All these weighting vectors are

compatible with the DM's ranking over the set of criteria and he/she is totally unaware of their existence and unjustifiable exclusion during the implementation of the method. Apart from this, it is possible that this plethora of weightings may cause major differentiations in the final results, when used in outranking or other MCDA approaches e.g. rank reversals, when implementing the ELECTRE II-III-IV methods.

The WAP software tool

The WAP method (Tsotsolas, et al., 2016) is based on Simos Method approach and it incorporates specific processes focusing on robust concern of the inferred results. The method includes several robustness rules proposed by Siskos and Tsotsolas (2015) concerning the production of tangible and adequately supported results when Simos method is used. In particular the following rules are followed:

- Computation of the variation range of the weight of each one of the n criteria by solving $2n$ linear programs of Max-Min type (rule 1)
- Computation of the average weighting vector ("barycenter") of all different vectors (from the $2n$ solutions obtained in the former rule), as a more representative weighting solution in the hyper-polyhedron (M-N Average) (rule 2)
- Visualisation of the ranges of variation of the criteria weights for a more comprehensively perceive the extent of the possible instability (rule 5)
- Computation of the robustness measure ASI (Average Stability Index) (rule 7)

Additionally to the aforementioned rules the WAP method includes a process for receiving extra information from the DM concerning the difference between the weights of the criteria (feedbacks).

The flow diagram in Figure 1 shows the main steps – processes of WAP Method.

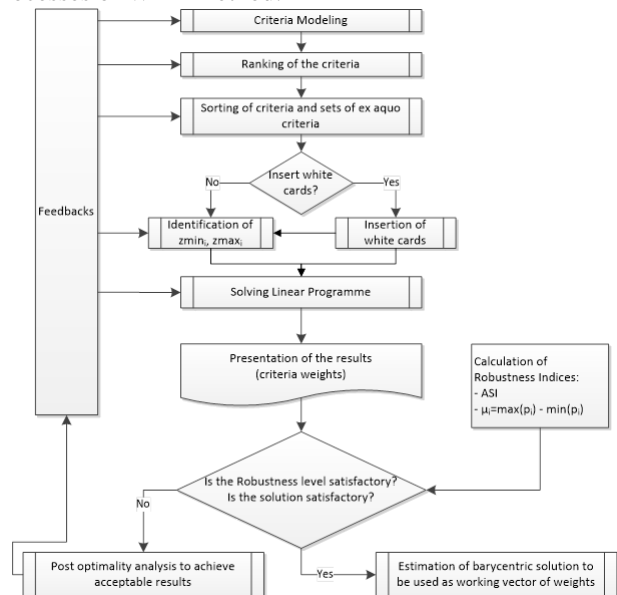


Figure 1 -Mmain steps – processes of WAP Method.

WAP method enriches the preferential information used in a friendly and comprehensive by the DM way and at the same time it leads to the estimation of weighting vectors with higher robustness. In Table 1 a comparison of WAP and Revised Simos Method is shown.

Table 1: WAP Method vs Simos Method

WAP Method	Simos Method
Prioritise Criteria (linear constraints)	Prioritise Criteria (using cards)
Increase z_r indices to increase weights difference	Insert white cards to increase weights difference
Solving LP model to calculate weights	Calculate weights using Simos algorithm
Perform full Robustness Analysis	Limited Robustness Analysis
Continue with feedbacks if necessary	NA

The key point of the WAP method is the use of the z_r indices for every pair of successive criteria or sets of ex aequo criteria sorted according to their ranking.

z_r : how many times a criterion is more important than the previous one in the ranking

DM is not asked to identify precisely these z_r indices but instead a range of value $[z_{min_r}, z_{max_r}]$. For two successive criteria or sets of ex aequo criteria, (ex. g_r, g_{r+1}) the range $[z_{min_r}, z_{max_r}]$ is identified, so as:

$$z_{min_r} \leq z_r \leq z_{max_r},$$

$p_r = z_r p_{r+1}$, where p_r is the weight of g_r and p_{r+1} is the weight of g_{r+1} .

The z index, used in revised Simos, can be directly calculated by the product of the z_i indices:

$$z_1 z_2 \dots z_{m-1} = (p_1/p_2)(p_2/p_3) \dots (p_{m-1}/p_m) = p_1/p_m = z.$$

In order to make the whole process easier for the DM to identify these values, special visual interactive techniques were developed and implemented in the WAP tool. Through visual techniques the DM is asked to express the limits of the ranges of the relative importance between two consecutive criteria or set of ex aequo criteria for all of the pairs, as shown in Figure 2.

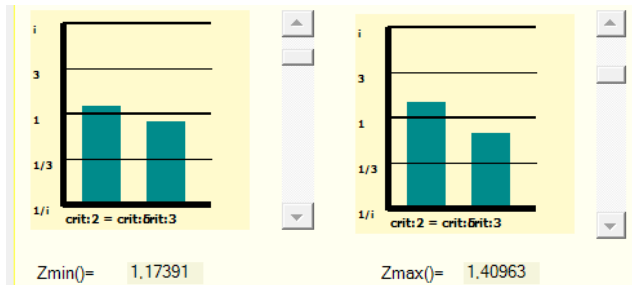


Figure 2 - Define $[z_{min_r}, z_{max_r}]$ in WAP Method tool

Having identified the z_{min_r} and z_{max_r} for all of the pairs of the successive classes The following LP is constructed

and solved for calculating a wide range of multiple optimal solutions.

$$\text{Min } p_i \ \& \ \text{Max } p_i, \text{ for } i = 1, 2, \dots, n$$

s.t.

$$\text{solutions } \in \mathbf{P}$$

From the set of the $2n$ vector of weights the barycentric solution is estimated and it can be used as a representative solution in the outranking methods. The produced solutions lead to the calculation of robustness measures by utilising two indices. The first index is the range between the maximum and minimum values of the criteria weights for every criterion, as these values are estimated at each vertex of the hyper-polyhedron. This gives a picture, at first glance, of the extent of robustness in each criterion. For the i -th criterion the index is estimated as:

$$\mu_i = (\max(p_{ij}) - \min(p_{ij})),$$

$$i = 1, 2, \dots, n, \quad j = 1, 2, \dots, m,$$

p_{ij} is the weight of the i criterion of the j ,

n : the number of criteria and

m : the number of vertices of hyper-polyhedron

The second index represents the normalized standard deviation of the different solutions corresponding to the hyper-polyhedron vertices, where the value 1 corresponds to total robustness and 0 to complete un-robustness of the preference models (Grigoroudis and Siskos, 2010). This normalized index is called Average Stability Index (ASI):

$$ASI = 1 - \frac{\sum_{i=1}^n \sqrt{\left(m \left(\sum_{j=1}^m (p_{ij}^j)^2 \right) - \left(\sum_{j=1}^m p_{ij}^j \right)^2 \right)}}{m \sqrt{(n-1)}}$$

n : the number of criteria and

m : the number of vertices of hyper-polyhedron

WAP tool also supports the implementation of tomographical analysis (Spyridakos, et al., 2018), which is actually a discretization approach by using $n-1$ dimensional cutting hyper-planes, creating half-spaces in the n -dimensional space estimated hyper-polyhedron of the criteria weights. At each one of the tomographical levels new solutions belonging to the polyhedral set \mathbf{P} are calculated and the robustness indices are updated.

For the case where the robustness of the results is low, feedback capabilities are provided by WAP tool. The DM may go back to update or alter some of the initial preferences such as the values of the z_{min} and z_{max} or set limits to criteria weights (Fig. 3), triggered and informed by the estimated minimum and maximum values of the criteria weights and the robustness indices.

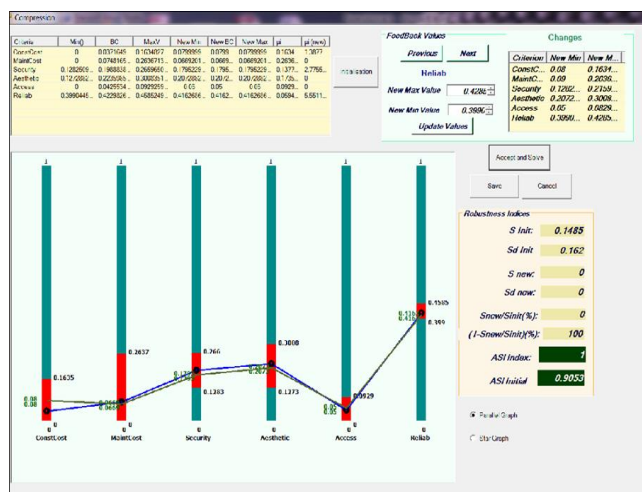


Figure 3- Feedbacks in WAP Method tool

Future Developments

In its current version WAP software tool works as stand-alone desktop application receiving text (.txt) files from three different DSSs, namely: TALOS, MIDAS and Minora. In order to increase its interoperability and to accelerate its further development, WAP software tool will be redeveloped as module in diviz platform, which constitutes a stable and open framework for modular development for MCDA methods and processes.

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Forthcoming meetings

- 10-11/12/2018
3rd IMA Conference on The Mathematical Challenges of Big Data
Double Tree by Hilton Hotel London, UK
<https://ima.org.uk/9104/3rd-ima-conference-on-the-mathematical-challenges-of-big-data/>
- 10-13/12/2018
IEEE Big Data 2018 - IEEE International Conference on Big Data
Seattle, WA, USA
<http://cci.drexel.edu/bigdata/bigdata2018/index.html>
- 16-19/12/2018
ISAAC 2018 - 29th International Symposium on Algorithms and Computation
Jiaoxi, Yilan County, Taiwan
<http://isaac2018.ie.nthu.edu.tw/>
- 16-19/12/2018
IEEM 2018 - IEEE International Conference on Industrial Engineering and Engineering Management
Bangkok, Thailand
<http://www.ieem.org>
- 17-19/12/2018
Vienna Workshop on Computational Optimization
Vienna, Austria
<http://vwco18.univie.ac.at/>
- 16-18/1/2019
HM 2019 - 11th International Workshop on Hybrid Metaheuristics
Concepción, Chile
<http://hm2019.ing.udec.cl/>
- 7-8/2/2019
ORBEL 33 - annual conference of the Belgian Operational Research Society
Hasselt, Belgium
<https://www.orbel.be/orbel33/>
- 7-8/2/2019
ORBEL 33 - annual conference of the Belgian Operational Research Society
Hasselt, Belgium

<https://www.orbel.be/orbel33/>

- 17-22/2/2019
EUROCAST 2019 - Workshop on Theory and Applications of Metaheuristic Algorithms
Las Palmas, Canary Islands, Spain
<http://eurocast2019.fulp.ulpgc.es/workshops-and-participation>
- 19-21/2/2019
Conférence ROADEF 2019
University of Le Havre, France
<https://roadef2019.univ-lehavre.fr/>
- 10-13/3/2019
EMO-2019 - 10th International Conference on Evolutionary Multi-Criterion Optimization
Michigan, USA
<https://easychair.org/conferences/?conf=emo2019>
- 11-13/4/2019
**89th meeting of the EURO Working Group on Multiple Criteria Decision Aiding
Trento, Italy.**
<https://event.unitn.it/ewg-mcda2019/>
Main organizers: Michele Fedrizzi and Matteo Brunelli
- 24-26/4/2019
EvoCOP 2019 - 19th European Conference on Evolutionary Computation in Combinatorial Optimisation
Leipzig, Germany
http://www.evostar.org/2019/cfp_evocop.php
- 22-24/5/2019
Integer Programming and Combinatorial Optimization - IPCO XX
Michigan, USA
umich.edu/~ipco2019conf
- 27-29/5/2019
ICDSSST 2019 EWG-DSS 5th International Conference on Decision Support System Technology
Madeira, Portugal
<https://icdssst2019.wordpress.com/>
- 27-29/5/2019
2019 CORS Conference
Saskatoon, Saskatchewan, Canada
<https://www.cors2019.ca>
- 5-7/6/2019
EWGLA XXV - EURO Working Group on Location Analysis
Brussels, Belgium
<http://www.vub.ac.be/en/events/ewgla2019>
- 9-12/6/2019

INFORMS-ALIO 2019

Cancun, Mexico

<http://meetings2.informs.org/wordpress/2019international/>

- 10-12/6/2019
INOC 2019 International Network Optimization Conference
Avignon, France
<https://inoc2019.sciencesconf.org/>

- **16-21/6/2019**
The 25th International Conference on Multiple Criteria Decision Making (MCDM 2019)
Istanbul, Turkey

<http://www.mcdm2019.org/>

The 25th International Conference on Multiple Criteria Decision Making (MCDM2019) will take place at Istanbul Technical University, Istanbul, Turkey from June 16th to June 21st, 2019. www.MCDM2019.org is the official web site of our conference.

It is the biennial conference of the International Society on MCDM. MCDM conferences aim to bring together researchers and practitioners within the broad field of Multiple Criteria Decision Making. The main theme of MCDM2019 is "MCDM beyond the Information Age". The topics and application areas covered by the conference are diverse and can be seen at the conference web site

We would like to invite you cordially to send proposals for organizing sessions with four presentations. We will be happy to hear about mini-track proposals that contain multiple sessions. Each proposal should include the topic of the session(s) as well as person(s) in charge of it (including affiliation and email address) and a brief description of the session's scope. You may send your proposals to mcdm2019@itu.edu.tr by November 7, 2018. Abstract submission for contributed talks is also open. For submitting abstracts of up to 4000 characters (with spaces), please visit "submissions" web page at www.mcdm2019.org. Please notice that the deadline for abstract submission is January 30, 2019.

There will be a number of special issues of OR journals dedicated to the conference. The journals, special issue calls and submission deadlines will be announced as the information becomes available. For further information please visit our conference web site www.mcdm2019.org or contact the Conference Secretariat by e-mail mcdm2019@itu.edu.tr.

You are all most welcome to MCDM2019, the 25th organization of MCDM conferences...

Istanbul'da görüşmek üzere! (See you in Istanbul!)

Sincerely,

İlker Topcu (General Chair, Istanbul Technical University)

Özgür Kabak (General Co-chair, Istanbul Technical University)

Özay Özaydın (General Co-chair, Doğuş University)

Şule Önsel Ekici (Organizing Committee Chair, Doğuş University)

Serpil Sayın (Program Committee Chair, Koç University)

- 19-21/6/2019
Advances in Decision Analysis Conference
Milan, Italy
<http://connect.informs.org/das/conferences#ADA2019>
- 23-26/6/2019
EURO 2019
Dublin, Ireland
<https://www.euro2019dublin.com/>
- 13-17/7/2019
GECCO 2019 - Genetic and Evolutionary Computation Conference
Prague, Czech Republic
<http://gecco-2019.sigev.org/>
- 28-31/7/2019
MIC 2019 - 13th Metaheuristics International Conference
Cartagena de Indias, Colombia
<http://mic2019.uniandes.edu.co>
- 3-8/8/2019
Sixth International Conference on Continuous Optimization (ICCOPT)
Berlin, Germany
<https://iccopt2019.berlin/>
- 28-30/8/2019
9th IFAC Conference on Manufacturing Modeling, Management and Control MIM 2019
Berlin, Germany
<https://blog.hwr-berlin.de/mim2019>
- 3-6/9/2019
Operations Research 2019
Dresden, Germany
<http://tu-dresden.de/or2019>
- 4-7/9/2019
ODS2019 - XLIX Annual Meeting of AIRO - Italian Operations Research Society
Genova, Italy
<http://www.airoconference.it/ods2019/>
- 12-14/9/2019
EUROGEN 2019 Conference - Evolutionary and Deterministic Methods for Design, Optimization and Control with Applications to Industrial and Societal Problems
Guimarães, Portugal
<http://eurogen2019.dep.uminho.pt>
- 25-27/9/2019
SOR '19 The 15th International Symposium on Operations Research in Slovenia
Bled, Slovenia
<http://sor19.fov.uni-mb.si/>

- 26-28/9/2019
90th Meeting of EURO Working Group on MCDA
IMT Atlantique, Brest, France
<http://conferences.imt-atlantique.fr/mcda90>
Main organizer: Patrick Meyer
(colocated with 16th Decision Deck Workshop)
- 20-23/10/2019
2019 INFORMS Annual Meeting
Seattle, USA
<http://meetings2.informs.org/wordpress/seattle2019/>
- 21-26/7/2020
IFORS 2020
Seoul, South Korea
www.informs.org
- 11-14/7/2021
EURO 2021
Athens, Greece
<https://www.euro-online.org>

Seminars

SEMINAIRE « MODELISATION DES PREFERENCES ET AIDE MULTICRITERE A LA DECISION »

Responsable: Daniel VANDERPOOTEN
(le mardi à 13h45 – salles à préciser)

Prochaines réunions

23 octobre 2018 - Conférence de **André Rossi**
LAMSADE – Université Paris Dauphine
Problèmes d'optimisation dans les réseaux de capteurs sans fils

27 novembre 2018 - Conférence de **Stefano Moretti**
LAMSADE – Université Paris Dauphine
Ranking objects from a preference relation over their subsets

18 décembre 2018 - Conférence de **Thibaut Lust**
LIP6 – Université Pierre et Marie Curie
Interactive multiobjective combinatorial optimization with imprecise trade-offs

Web site for Announcements and Call for Papers:
www.cs.put.poznan.pl/ewgmcda



Books

Multiple Criteria Decision Making

Series Ed.: C. Zopounidis

This book series focuses on the publication of monographs and edited volumes of wide interest for researchers and practitioners interested in the theory of multicriteria analysis and its applications in management and engineering. The book series publishes novel works related to the foundations and the methodological aspects of multicriteria analysis, its applications in different areas in management and engineering, as well as its connections with other quantitative and analytic disciplines. In recent years, multicriteria analysis has been widely used for decision making purposes by institutions and enterprises. Research is also very active in the field, with numerous publications in a wide range of publication outlets and different domains such as operations management, environmental and energy planning, finance and economics, marketing, engineering, and healthcare.

<https://www.springer.com/gp/book/9783319905983>

Call for Applications for the International MCDM Doctoral Dissertation Award 2019

At the 25th International Conference on Multiple Criteria Decision Making (MCDM), the International Society on Multiple Criteria Decision Making will bestow the MCDM Doctoral Dissertation Award upon a scholar who has recently obtained a doctoral degree and demonstrated excellence in her or his doctoral dissertation research in Multiple Criteria Decision Making or a related field. The MCDM Doctoral Dissertation Competition identifies and recognizes outstanding doctoral dissertation research, completed on January 1, 2017 or later, in the development of theory, methodology, and/or the application of theory or methodology to MCDM.

The MCDM Doctoral Dissertation Award Committee will evaluate the applications, identify finalists, and choose the winner. The award will be announced at the 25th International Conference on Multiple Criteria Decision Making, Istanbul, Turkey, June 16 to June 21, 2019. Each finalist is required to give a talk at the conference. The finalists' conference fees will be waived.

Deadline for applications: Please email the zip file of the application packet to the awards committee at phdaward@mcdmsociety.org by February 15, 2019. The finalists will be selected and all applicants will be informed about the results of their applications by April 1, 2019.

Eligibility: Those whose dissertations are in MCDM or a related field and who graduated with a doctoral degree on or after January 1, 2017. Only dissertations that are in English are eligible.

Application (documents): The application packet should include the following documents (all of which must be in English, except possibly the diploma):

1. Cover letter.
2. Applicant's CV, not exceeding 3 pages.
3. Scanned copy of the original diploma of the Doctoral Degree.
4. Electronic copy of the Doctoral Dissertation.
5. Extended Abstract of the Doctoral Dissertation in English, not exceeding four single-spaced pages.
6. Copies of publications/patents based on the Doctoral Dissertation, if any. Manuscripts accepted for publication in journals that are accompanied with the Editors' acceptance letter can also be submitted. These publications should be accompanied by a statement from the supervisor confirming that they are extracted from the dissertation.
7. An endorsement letter from the supervisor(s), highlighting the significance of the dissertation.
8. (Optional) Additional supporting letters that the applicant wishes to attach.

José Rui Figueira

Chair of the International MCDM Doctoral Dissertation Committee

Email: figueira@tecnico.ulisboa.pt

Call for Nominations Awards of the International Society on Multiple Criteria Decision Making

The international Society on Multiple Criteria Decision Making presents, at each of its international conferences, up to three awards to individuals in honor of their outstanding, long-lasting, and influential contributions to the field of MCDM. These awards are:

The MCDM Gold Medal: This is the highest honor that the International Society on Multiple Criteria Decision Making bestows upon a scholar who, over a distinguished career, has markedly contributed to the theory, methodology, practice and professional development of MCDM.

The MCDM Edgeworth-Pareto Award: This is the highest distinction that the International Society on Multiple Criteria Decision Making bestows upon a researcher or

practitioner of MCDM who has demonstrated a high level of creativity in developing novel areas of application of MCDM and associated methodology, markedly influencing the form of MCDM practice.

The Georg Cantor Award: This is the highest form of recognition that the International Society on Multiple Criteria Decision Making bestows upon a researcher who has personified the spirit of independent inquiry in developing innovative ideas in the theory and methodology of MCDM, significantly expanding the tools available to MCDM practice.

The 25th International Conference takes place in Istanbul, Turkey during June 16-21, 2019. Nominations are now sought for awards to be made at this conference. Nominations should be emailed not later than January 31st, 2019 to Jyrki Wallenius (jyrki.wallenius@aalto.fi). Please note the following with respect to making nominations:

- No self-nominations will be accepted.
- The nomination must clearly state for which award the nomination is being made.
- Provide a short statement as to why the nominee is worthy of the award, indicating his/her contributions to the MCDM field.
- Provide a CV for the nominee or a link to it.

Note that a condition of the awards is that the awardee attends the conference in person to receive the award and to present a plenary talk. More information concerning the awards and past awardees may be found at the website <http://www.mcdmsociety.org/content/awards>.

The members of the award committee for 2019 are as follows:

Valerie Belton, University of Strathclyde
Kalyanmoy Deb, Michigan State University
Salvatore Greco, Catania University
Murat Köksalan, Middle East Technical University and University of Michigan, Ann Arbor (President, MCDM Society).
Wojtek Michalowski, University of Ottawa
Theodor Stewart, University of Cape Town
Ilker Topcu, Istanbul Technical University (Istanbul Conference Chair)
Detlof Von Winterfeldt, University of Southern California
Jyrki Wallenius (Chair), Aalto University

The committee reserves the right to make its own nominations and/or not to make particular awards.

Special Issue "Multicriteria Decision Analysis and the Sustainability of Public Systems Worldwide"

A special issue of Sustainability,
<https://www.mdpi.com/journal/sustainability>
Impact Factor (2017): 2.075 |
5-year Impact Factor (2017): 2.177

Dear Colleagues,

Multicriteria decision analysis (MCDA) has been continuously and successfully applied to a countless number of problems related to public services, including health care, education, justice, energy, water, wastewater, sewerage, transports, and urban/rural development, to name a few. In general, policy makers are interested on methodologies capable of reducing public resources waste, which are scarcer each passing day, while they satisfy or exceed most of the stakeholders' expectations. Policies design should account for different (usually conflicting) criteria and points of view associated with the several stakeholders. These policies, meanwhile, must ensure the medium/long-term sustainability of public systems.

The studies of this Special Issue are expected to address, at least, one of the following topics:

- Recent and sound developments on MCDA methods used to solve the problem of resources allocation to public services;
- Design of new policies for public services;
- Evaluating whether stakeholders' expectations were fulfilled or exceeded;
- Study of the efficiency/effectiveness/quality/equity of public services;
- Analysis of the amount of resources that could be saved if public services were better performers;
- Comparison of the results (performance) of different policies with the same goal;
- Identification of priority areas requiring performance improvements and definition of strategies to accomplish them.

Please, submit your contributions using the link below, by **30th June 2019** (deadline for submissions). All submitted contributions will be peer-reviewed by, at least, two referees, through a single blind peer-review process.

https://www.mdpi.com/journal/sustainability/special_issues/Multicriteria_Decision

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Dr. Diogo Cunha Ferreira,
Prof. José Rui Figueira
Prof. Rui Cunha Marques
Guest Editors



Articles Harvest

(This section is prepared by Salvatore CORRENTE,
salvatore.corrente@unict.it)

Abbas, M., ElMaraghy, H. (2018). Co-platforming of products and assembly systems. *Omega*, 78, 5-20.

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Announcement:

The "Useful links" section of the group's homepage

(www.cs.put.poznan.pl/ewgmcd)

is being enlarged. Contributions of URL links to societies, research groups and other links of interest are welcome.

A membership directory of the European Working Group on "Multiple Criteria Decision Aiding" is available at the same site. If you would like to be listed in this directory please send us your data (see examples already in the directory).

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Web site for the EURO Working Group "Multicriteria Aid for Decisions"

A World Wide Web site for the EURO Working Group on "Multicriteria Aid for Decisions" is already available at the URL:

<http://www.cs.put.poznan.pl/ewgmcd/>

Web site Editor: Milosz Kadzinski
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This WWW site is aimed not just at making available the most relevant information contained in the Newsletter sections, but it also intends to become an online discussion forum, where other information and opinion articles could appear in order to create a more lively atmosphere within the group.



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