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From stakeholders analysis to cognitive mapping and Multi Attribute Value Theory: an integrated approach for policy support

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Highlights

- The study develops a multi-method framework to support public policy making.
- The framework integrates stakeholders analysis, cognitive mapping and MAVT.
- The framework facilitates group discussion and negotiation.
- The integrated decision support framework has been tested on a location case study.

From stakeholders analysis to cognitive mapping and Multi Attribute Value Theory: an integrated approach for policy support

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Abstract

One of the fundamental features of policy processes in contemporary societies is complexity. It follows from the plurality of points of view actors adopt in their interventions, and from the plurality of criteria upon which they base their decisions. In this context, collaborative multicriteria decision processes seem to be appropriate to address part of the complexity challenge. This study discusses a decision support framework that guides policy makers in their strategic decisions by using a multi-method approach based on the integration of three tools, i.e., (i) stakeholders analysis, to identify the multiple interests involved in the process, (ii) cognitive mapping, to define the shared set of objectives for the analysis, and (iii) Multi Attribute Value Theory, to measure the level of achievement of the previously defined objectives by the policy options under investigation. The integrated decision support framework has been tested on a real world project concerning the location of new parking areas in a UNESCO site in Southern Italy. The purpose of this study was to test the operability of an integrated analytical approach to support policy decisions by investigating the combined and synergistic effect of the three aforementioned tools. The ultimate objective was to propose policy recommendations for a sustainable parking area development strategy in the region under consideration. The obtained results illustrate the importance of integrated approaches for the development of accountable public decision processes and consensus policy alternatives. The proposed integrated methodological framework will, hopefully, stimulate the application of other collaborative decision processes in public policy making.

Key-words: Multiple criteria analysis, Decision analysis, Group decision and negotiations, Decision processes, policy analytics.

1. Introduction

Public policy making is an inherent multi-attribute problem: it is simultaneously characterized by many different dimensions pursuing heterogeneous and often conflicting objectives. Moreover, decision-making in this context is often complicated by (i) multiple stakeholder views calling for a participative decision process able to include different perspectives and to facilitate the discussion, (ii) long time horizons which add further structural uncertainty to the policy cycle; (iii) the irreversible allocation of scarce public resources, and (iv) the need for legitimation and accountability of results and processes (Tsoukiàs et al., 2013).

Public policies can thus be considered as complex systems and as such present multiple possible descriptions, all of them correct. As a consequence, any model is the representation of reality resulting from a number of arbitrary assumptions, implying the existence of two or more different correct representations of the same real-world system (Munda, 2004). Therefore, the specification of the objectives and alternatives should be the result of a collective effort in order to construct a realistic and appropriate model of the problem.

To help addressing these complexities in a structured way, the use of policy analytics (Tsoukiàs et al., 2013), which represent a framework for the use of analytics in supporting the policy cycle, has gained attention in recent years. Within this context, Multicriteria Analysis (Figueira et al., 2005) can play a fundamental role in structuring and supporting complex policy problems with multiple and often conflicting objectives, although empirical research indicates systematic deviations of individuals from rational behaviour in actual intuitive decision making (Kahneman, 2011).

The purpose of this study is to provide an operational decision support framework that guides policy makers in their future strategic decisions by using a mixed method approach, that allows to justify with rational arguments the allocation of public resources by integrating different approaches in order to better handle critical steps and avoid biases. Mixed–method approaches (e.g. Morse and Niehous, 2009; Creswell and Plano Clark, 2011) allow to cope with multi-dimensional systems, the need for multi-level perspectives as well as multi-actors evaluation using both qualitative approaches, for exploring the general problem, and quantitative approaches, for better investigating alternative options and performances.

As observed by Myllyviita et al. (2014), although there is a wide scholarly discussion on mixing methods, successful real examples in environmental decision and policy making are still scarce. Moreover, so far the assumed benefits of using mixed methods have not been systematically tested (Myllyviita et al., 2014). There is thus an evident need to pursue and to better communicate the benefits of mixing (Myllyviita et al., 2014) and the research presented in this paper is an attempt to fill in this gap.

In particular, this paper proposes a group-learning process under a decision support methodological framework evolving through three main methods, i.e. stakeholders analysis, cognitive mapping and multicriteria analysis.

The integrated decision support framework was tested on a real world case study concerning the location of new parking areas in a UNESCO site in Southern Italy. Locating new parking areas can be perceived at the same time as a desirable and undesirable facility location problem.

In this context, the use of multi-criteria methodological frameworks started gaining attention in recent years. Nevertheless, very few applications can be found in this field. For example, an interesting study developed by Jelokhani-Niaraki and Malczewski (2015) dealt with the complexity of parking site selection by combining Multicriteria Decision Aiding (MCDA) with Geographic Information Systems (GIS) through a web-based application designed to support participation and testing the method with students. Other authors (e.g. Yuejun et al., 2012) dealt with the parking site selection problem by combining MCDA and GIS, using the AHP method (Saaty, 2012) and focusing on the comparison of alternatives' phase. As highlighted in the literature review by Myllyviita et al. (2014), different mixes of methods have been tested and, in particular, cognitive mapping and stakeholders analysis have respectively already been used in combination with Multicriteria Analysis (e.g. Stewart et al., 2010) but, so far, there are no applications testing in a real setting the joint use of the 3 methods proposed in this study, i.e. stakeholders analysis (in the form of a power interest matrix, Dente, 2014), cognitive maps (Eden, 1988), and the specific Multicriteria technique named Multi Attribute Value Theory (Keeney and Raiffa, 1976). The reasons for the choice of this specific mix of methods can be summarized as follows: (i) cognitive maps seem one of the most promising tools for problem structuring prior to the application of Multicriteria Decision Aiding (e.g. Belton and Stewart, 2002; Stewart et al., 2010), as detailed in section 2.2, (ii) stakeholders analysis in the form of a power interest matrix is particularly suitable for complementing the Multi Attribute Value Theory technique given that the latter in a collaborative decision process context does not efficiently support the achievement of a consensus in the preference elicitation phase (e.g. Ferretti and Comino, 2015), thus calling for the need to aggregate different viewpoints according to their different levels of importance, as discussed in section 2.3 and in the conclusions, and, finally, (iii) stakeholders analysis has shown to be a very important preliminary step in multi attribute decision making processes (Dente, 2014), as detailed in section 2.1. The approach proposed in the present paper has thus an innovative value, which stems not only from the experimentation of the mix of the above mentioned specific techniques to support the overall planning process with a participatory approach, but also from their testing in the context of public policy making and cultural heritage management, where the combination of qualitative and quantitative methods seems to yield greater benefits (Myllyviita et al., 2014).

Another interesting aspect of the work is linked to the use and demonstration of how prescriptive decision analysis and participatory problem structuring can lead to the generation of new consensus alternatives in a real decision making process. Indeed, the design of alternatives has recently gained attention in the scientific literature (Colorni and Tsoukiàs, 2013; Raiffa, 2007; Raiffa, 1990) and there is a need for testing different tools in order to support innovative design of better alternatives. As highlighted in section 3.2.4, the mixed method approach proposed in this paper helped the participants to generate a new consensus alternative at the end of the process.

The proposed integrated decision aid is thus expected to constitute a transferable framework to support policy makers in their strategic decisions.

The remainder of the paper is organized as follows: section 2 presents the overall methodological background, section 3 illustrates the real world case study on which the mixed method approach has been tested and, finally, section 4 proposes a detailed discussion of the results obtained from the integrated decision support process and some conclusions for further developments of the research.

2. Methodological background: integrating stakeholders analysis, cognitive mapping and Multi Attribute Value Theory

This paper proposes an integration of three different tools in order to provide an operational framework able to support strategic choices and public policies.

In particular, the mixed-method approach combines stakeholders analysis (Dente, 2014), cognitive mapping (Eden, 1988) and Multi Attribute Value Theory (Keeney and Raiffa, 1976) which are powerful methods of analysis and evaluation and that can inform each other and foster synergies, as will be presented in the following paragraphs. Among the different possibilities for designing mixed methods research, the sequential design (Creswell et al., 2011) has been chosen, as it seems particularly appropriate in the context of policy making where the planning process should follow the subsequent phases of policy formulation since the very beginning. Mixing in this study means that methods have progressively been linked to complement each other or to cover a larger proportion of the different tasks in the planning process. As will be shown in section 3, the sequential design applied in this study allowed to begin with the identification of the problems and objectives to be reached by a qualitative investigation, which is followed by a quantitative analysis to define the best performing alternative option.

2.1 Stakeholders analysis

In public policy making the actors and their behaviors represent the core of any possible theoretical model (Dente, 2014; Boerboom and Ferretti, 2014). The actors are those individuals or organizations that make the actions able to influence the decisional outcomes and that do it because they pursue goals regarding the problem and its possible solution, or regarding their relations with other actors (Dente, 2014). In particular, any actor having a vested interest in the decision process, either directly affecting or being affected by its resolution, including experts and the public, is named stakeholder. The first, essential, step of a decision process to support public policies formulation thus consists in the identification of the stakeholders and of their objectives (Dente, 2014).

Stakeholders have access to and can mobilize different types of resources (i.e. political, economic, legal and cognitive resources), they can be grouped into different categories (i.e. political actors, bureaucratic actors, special interests, general interests and experts) and they can have different roles (i.e. promoter, director, opposer, ally, mediator, gatekeeper and filter) (Dente, 2014). These analytical categories are needed to simplify the analysis, as they supply useful guidelines to interpret (and forecast) the behaviors.

The final aim of the analysis is to develop a strategic view of the human and institutional landscape, the relationships between the different stakeholders and the issues they care about most.

To this end, various stakeholders mapping techniques exist and the most used one is the power/interest matrix proposed by Mendelow (1981).

Through the power/interest matrix it is possible to answer the following questions:
(i) how interested is each stakeholder to impress its expectations on the project decisions?
(ii) Do they mean to do so? Do they have the power to do so?
By grouping stakeholders in the power/interest matrix, project management can thus produce a better picture of how communication and relationships between stakeholders can affect the project and its implementation. Identifying and studying the stakeholders involved in a decision problem is particularly important in the domain of public decision making since key representatives can then be invited to participate in brainstorming sessions where cognitive mapping techniques can be used to identify and discuss the objectives to be pursued with a more systemic and interdisciplinary approach. As a matter of fact, scientific research has demonstrated that the identification of the fundamental objectives associated to a decision is not an easy task and that without support people are often aware of only half of the objectives that turn out to be relevant to them (Bond et al., 2008). Collaborative decision processes can thus help to tackle this challenge. The existence of a plurality of points of view allows to imagine different possible approaches to the problem, different intervention methods, and different decisional procedures. That is, complexity increases the number of possible alternatives and is often an important asset (Dente, 2014). This is why the methodological process proposed in this paper combines stakeholders analysis (the reader interested in knowing more about how to use stakeholder analysis can refer to Dente, 2014) with cognitive mapping (Eden, 2004) for purposes of knowledge acquisition and problem structuring.

2.2 Cognitive mapping

Cognitive mapping is a casual-based mapping technique where concepts representing elements of a complex problem are organized and structured using arrow diagrams. Hence, elements or concepts are represented as nodes, while arrows represent the connections and relationships among them (Mendoza and Prabhu, 2003). When there are a number of perspectives on a problem, mapping is a good way of drawing them together and negotiating a new vision, which will enable all interested parties to work as a group. Indeed, cognitive mapping is a simple graphic tool that can be used to capture and clarify people’s ideas and perceptions (Sheetz et al., 1994).
In particular, cognitive mapping is well suited for complex problems where many aspects and dimensions of the problem are difficult to comprehend adequately, or in some cases may even be totally indeterminate. For such problems, it may be better to use “soft evaluation” methods that do not require explicit quantifiable measures typical of most formal methodologies (Mendoza and Prabhu, 2009). The reader interested in getting more advice on how cognitive mapping can be used in practice can refer to Belton and Stewart (2002) and Gordon et al. (2014).
The key benefits of using cognitive mapping can thus be summarized as follows: (i) it provides a well arranged systematisation of available concepts and theories; (ii) it facilitates access to key concepts and

theories for novice and other users; and (iii) it can be very helpful in organizing and structuring value trees (Mendoza and Prabhu, 2009).

Consequently, the use of cognitive maps for structuring problems prior to the application of Multi-criteria Decision Aiding (MCDA) has been discussed by various authors, e.g. Bana e Costa et al. (1999), Montibeller and Belton (2006), Belton and Stewart (2002, pp. 48–51), Kpoumié et al. (2013) and Stewart et al. (2010). In this paper, cognitive mapping has been integrated with stakeholders analysis in order to follow a more inclusive approach in the identification of the relevant objectives and criteria.

2.3 Multi Attribute Value Theory

Following from the previous paragraph, the third methodology that underpins the integrated decision aiding process proposed in this paper is a particular Multi-criteria Analysis technique named Multi Attribute Value Theory (Keeney and Raiffa, 1976) (MAVT). MAVT is a well-researched and well-founded methodology, and a relatively simple MCDA method. Indeed, research in Multi Attribute Decision Making has suggested the use of simple, understandable and usable approaches for solving decision-making problems (Ulengin et al., 2010). Other reasons for choosing MAVT to complete the present methodological framework are as follows: (i) since it is founded on fundamental axioms of rational choice (e.g. Von Winterfeldt and Edwards, 1986), results are justifiable, which is vital for policy decisions that have to be defended in the policy arena; (ii) it can deal with a large number of alternatives without an increase of the elicitation effort compared to a study with a smaller number of alternatives (Schuwirth et al., 2012), thus ensuring replicabililty to the whole process; and (iii) it allows for both qualitative and quantitative parameters to be evaluated.

From the methodological point of view, MAVT can be used to address problems involving a set of alternative options that have to be evaluated on the basis of conflicting objectives. By being able to handle quantitative as well as qualitative data, MAVT plays a crucial role in the field of environmental decision-making and policy design where many aspects are often intangible (Ferretti and Comino, 2015).

The iterative process followed in this study can be described as shown in Figure 1. While the MAVT modelling steps (items 1 to 7 in Figure 1) have already been presented in the decision analytic literature (e.g. Keeney, 1992; Belton and Stewart, 2002), the proposed diagram relates the three stages of the planning and decision making process (Simon, 1977, Malczewski, 2004) to the above mentioned steps as well as to the specific tools mixed in this study. The diagram thus shows the inputs to the different steps as well as the characteristics of the output for policy making.

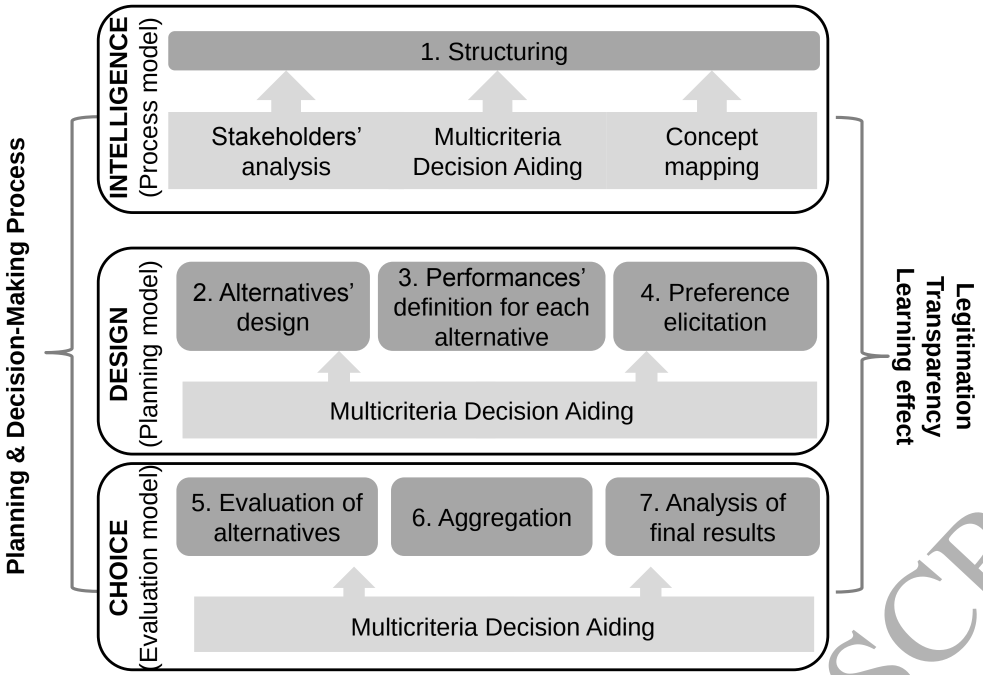

Figure 1 The methodological process followed in the study

In particular, the first step is crucial since it concerns the definition of the problem, which implies identifying and structuring the fundamental objectives and related attributes (i.e. measurable characteristics used to quantify the objectives) using a value tree.

The second step consists in the identification and creation of alternative options. The alternatives are the potential solutions to the decision problem. Methods and models such as visioning, problem structuring methods and scenario planning can help to promote creativity for the generation of good strategies and strategic options. Once the alternative options have been identified, it is necessary to determine the level of each attribute for each alternative. The performances of each alternative specify for each attribute the level of achievement of the objective (step 3). This step, contrary to the subsequent preference elicitation one, which is more subjective, has to be as objective as possible and preferably done by experts.

The following step consists in the modelling of preferences and value trade-offs. Before the weights can be elicited, an appropriate aggregation technique has to be determined, as the meaning and existence of the aggregation parameters depends on the aggregation method. Different strategies are available for the task of preference elicitation. The holistic scaling and the decomposed scaling strategies are the most used in practice (Beinat, 1997). According to the former, an overall value judgment has to be expressed of multiattribute profiles, which can be either the real alternatives or artificially designed profiles. Weights (i.e. scaling constants) and marginal value functions (which translate the performances of the alternatives into a value score representing the degree to which a decision objective is achieved) are then estimated through optimal fitting techniques (e.g. regression analysis or linear optimisation) and are the best representation of the assessor's judgments. According, instead, to the decomposed scaling technique, the multiattribute value function is broken down into simpler sub-tasks (i.e. the marginal value functions and the weights) which are assessed separately. The aim of decomposed scaling is to construct the multiattribute model for evaluating decision alternatives while the aim of holistic scaling is to make an inference about the underlying value functions and weights (Beinat, 1997). The decomposed scaling approach is less cognitive demanding than the holistic scaling one and thus more suitable to be used for public policy processes with the participation of stakeholders and experts in many fields not necessarily related to decision aiding. The case study illustrated in the present paper will follow the decomposed scaling approach, as will be illustrated in section 3.

The preference elicitation step also consists in the determination of the appropriate aggregation rule to be used in step 6.

The fifth step consists in the evaluation of the alternatives regarding each sub-objectives (i.e. applying the marginal value functions to the attribute levels of each alternative) in order to aggregate the values and calculate the overall performance. To this end, MAVT includes different aggregation models (step 6), but the simplest and most used one is the additive model (Belton & Stewart, 2002):

$$V(a) = \sum_{i=1}^{n} w_i \times v_i(a_i) \qquad (1)$$

where $V(a)$ is the overall value of alternative a, $v_i(a_i)$ is the single attribute value function reflecting alternative a's performance on attribute i, and w_i is the weight assigned to reflect the importance of attribute i. The key condition for the additive form in (1) is mutual preference independence. Attributes i and j are preference independent if trade-offs (substitution rates) between i and j are independent from all other attributes. Mutual preference independence requires that preference independence holds for all pairs i and j. Since (1) aggregates the options' performance across all the attributes to form an overall assessment, it is thus a compensatory aggregation rule.

Finally, a sensitivity analysis is recommended in order to test the stability of the obtained results with regards to variations in the inputs. As a result, a final recommendation can be obtained and further discussed with the Decision Makers and stakeholders.

Throughout all the above mentioned steps, the use of experts' panels may expand the knowledge basis and may serve to avoid possible biases, typical of a situation with a single expert. On the other side, the use of experts' panels has a range of problems associated with it, such as the panel composition, the interaction mode between panel members and, above all, the aggregation of panel responses into a form useful for the decision (Beinat, 1997).

The reader interested in more examples concerning the application of MAVT in environmental decision making contexts car refer for instance to Schuwirth et al. (2012) and to Ferretti and Comino (2015).

3. Case study application

3.1 Contextualization and alternatives' definition

The policy problem under analysis concerns the need for an integrated decision aid to support the evaluation of alternative parking areas in a complex territorial system. The area under investigation is the Municipality of Alberobello in southern Italy, which was declared a UNESCO (United Nations Educational, Scientific and Cultural Organization, http://whc.unesco.org/) site in 1996 due to the presence of the "Trulli", a particular form of building construction which derives from prehistoric techniques that are still functioning in the modern world and that nowadays have thus a unique value.

In particular, the core area of the UNESCO site "Trulli of Alberobello" (i.e. the area of universal excellence which makes the site unique worldwide) consists of two neighbourhoods: "Rione Aia Piccola" and "Rione Monti". They have a uniform building fabric formed by the unification of single trulli reflecting a serial, spontaneous organization. Three more single buildings are part of the core zone: the "Trullo Sovrano" (the only Trullo with an upper floor), "Casa D'Amore" (the first house built using binder in Alberobello) and "Casa Pezzolla" (example of a mimesis between the Trullo construction and the houses of the late eighteenth century, which were typical of the Murgia towns) (SiTI, 2012).

The reason why this area represents a complex territorial system and, thus, a challenging decision-making environment, is linked to the fact that being a UNESCO site means that conflicting needs coexist in the same area, i.e. conservation and protection needs as well as new development needs.

Given the increasing flows of people visiting Alberobello's municipality every year and the severe shortage of parking spaces, the availability of parking areas has emerged as a serious concern for the Municipality. The present situation is indeed characterized by heavy traffic problems, roads overcrowded with unregulated parking, high levels of pollution, negative aesthetic impacts and, overall, bad services to tourists and residents. Therefore, the Municipality carried out a technical study and identified 5 different locations as suitable sites to host a new parking area (Figure 2). The general strategy followed by the municipality for the identification of the 5 suitable sites was based on the reuse as much as possible of former industrial/abandoned areas in order to minimize the consumption of new soil, which is one of the most important aspects of a UNESCO management plan (SiTI, 2012).

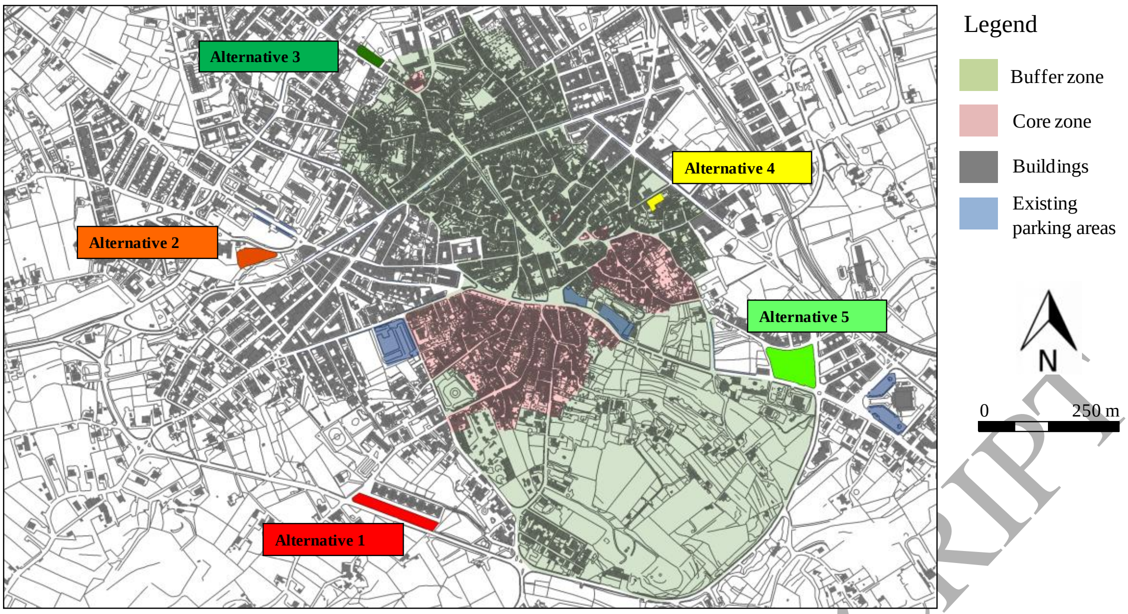

Figure 2 New parking areas proposed by the local authority for the municipality of Alberobello (Italy)

The buffer zone showed in Figure 2 is the area whose boundaries have been defined in order to protect and maintain the exceptional value of the core area as well as to limit negative development impacts on it.

The area (m^2) of each alternative under consideration is shown in Table 1.

Table 1. Area (m^2) of the alternatives under analysis

	Alternative parking locations				
	1	2	3	4	5
Area (m^2)	3,770	2,231	1,161	632	6,464

All the 5 alternatives represented good options for the Municipality which would have built them all but, given the limited availability of public resources, the demand in this case was for a priority order for the 5 proposed alternatives aiming at discovering the option that was more strategic to realize first. The ultimate policy objective was to develop consensus solutions for all the relevant stakeholders groups.

3.2 Model development

The methodological approach followed in this study is implemented in three phases:

(i) phase I is designed to identify the stakeholders involved in the problem;

(ii) phase II applies cognitive mapping to identify the relevant values and objectives and to formulate a collective value tree following Value Focused Thinking concepts (Keeney, 1992), and, finally,

(iii) phase III consists in the development of a Multi Attribute Value Theory model to rank the different options and provide robust recommendations to policy makers.

Figure 3 shows the integrated decision process that has been followed highlighting the inputs and outputs associated to the different phases of the sequential mixed methods design applied in the study.

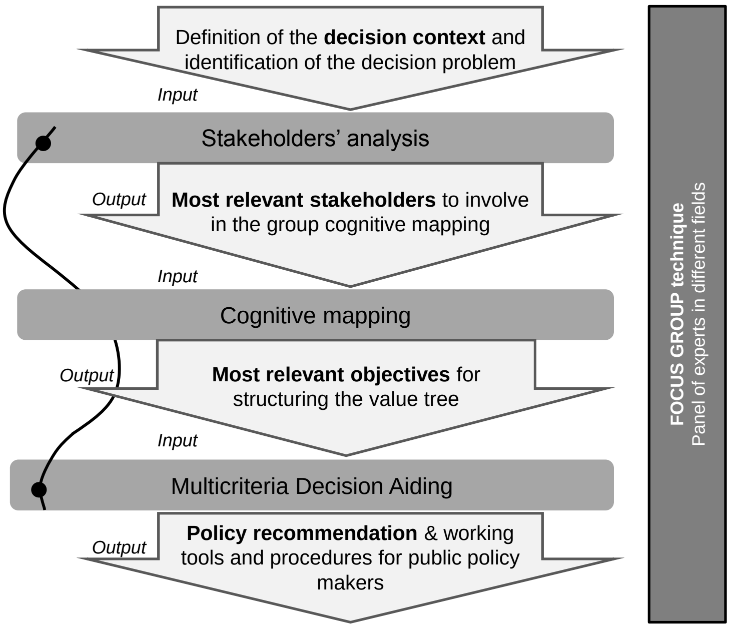

Figure 3 Specific outputs and inputs in the sequential design of the mixed methods approach applied in this study

3.2.1 Stakeholders analysis and cognitive mapping

This section shows how stakeholders analysis and cognitive mapping have been used as a tool to inform the definition of objectives and values to be used in the multicriteria model for the evaluation of the alternative options under consideration.

The development of new parking areas involves different stakeholders with conflicting objectives and interests.

The first step of the analysis thus consisted in a survey of the relevant stakeholders that can play a role in the process under investigation (Table 2). The stakeholders in this case were all the individuals or entities/institutions related to the use and management of parking areas in the municipality of Alberobello. The method used in this study to identify the stakeholders consisted in semi-structured interviews (Reed et al., 2009) with the main Decision Maker and with experts on the territorial context under analysis, to make sure that all the categories of relevant stakeholders were included in the process.

For each identified stakeholder, Table 2 provides the level of action, the type of resources they can activate and the category to which each stakeholder belongs. As a matter of fact, according to Dente (2014), in order to understand the dynamics of the stakeholders within the decision-making process it is extremely important to analyse the resources they have available (i.e. political resources, economic resources, legal resources and cognitive resources) and the categories they belong to (i.e. political actors, bureaucratic actors, special interests, general interests, experts).

Table 2 Survey of the relevant stakeholders linked to the construction of a new parking area in the municipality of Alberobello

ID	Stakeholders	Level	Type	Resources
1	Alberobello municipality	Local	Political	Political/economic
2	Local residents	Local	Special interests	Economic
3	Tourists	National	Special interests	Economic
4	Cultural associations	National	General interests	Cognitive
5	Tourist operators	National	General interests	Economic
6	Commercial associations	Local	Special interests	Economic
7	Local practitioners	Local/Provincial	Special interests	Cognitive
8	Local entrepreneurs	Local/Provincial	Special interests	Economic
9	Surrounding municipalities	Regional	Political	Political
10	Planners	Local/Provincial	General interests	Cognitive
11	Disable people associations	Local	General interests	Cognitive
12	Environmental associations	Local/Provincial	Bureaucratic	Cognitive/Political
13	Provincial government	Provincial	Political	Political/Legal
14	Environmental experts (universities, research institutes)	Local/Provincial	Experts	Cognitive

A power/interest analysis to better understand the dynamics existing among the identified stakeholders has also been developed and is available in Geneletti and Ferretti (2015). The results summarized in Table 2 constitute the basis of the next phase of the decision aiding process shown in Figure 3.

In order to build a shared vision of the decision-making problem and facilitate the identification of values influencing the decision under analysis, a brainstorming session was proposed to construct a cognitive map of the decision problem. With the aim of fostering creativity, the interactive setting of a focus group with 5 participants was used to build the cognitive map. The focus group was indeed a means to reach a cluster of consensual values through negotiation of ideas between individuals. The participants in this case were both experts and local stakeholders (ID number 2, 3, 4, 10 and 14 from Table 2) who were encouraged to identify concepts relevant to the decision problem under analysis. The participants were initially asked to specify all the variables that they thought influence a new parking area construction problem by means of a post it session. The post-it session was used to capture perceptions of the problem, goals and potential courses of action.

During the discussion, the ideas of the group were represented through a network of concepts and causal links on a whiteboard. The cognitive map was thus simultaneously co-constructed by the participants and the author of the paper, who worked as a facilitator during the brainstorming session, in a format that was viewable by all participants in the focus group. In particular, in this work, the CMap knowledge modelling kit of the Institute for Human and Machine Cognition (IHMC, http://cmap.ihmc.us) was used as a supporting tool to elicit, store, and handle the complexity revealed by the experts. Whereas the consensus on the socio-technical properties of the parking location problem was easier to achieve, thanks to the detailed explanation of the territorial context given by the experts participating in the focus group, the consensus on the objectives to be included in the map was achieved by allowing each participant to express her/his main concern and having this reflected in the map independently from the number of participants sharing that concern. For the sake of better readability of the final map, every stakeholder has been linked only to her/his main concern, despite the possibility of sharing more of them.

In this study the final map was prepared as a summary of the outputs of the post-it phase (e.g. repetitive concepts were eliminated and similar concepts were merged), it was then sent to the participants who confirmed that it could be used as the input to the subsequent phase of the decision process (i.e. the MAVT model development).

Figure 4 shows the relevant extract of the cognitive map that was drawn.

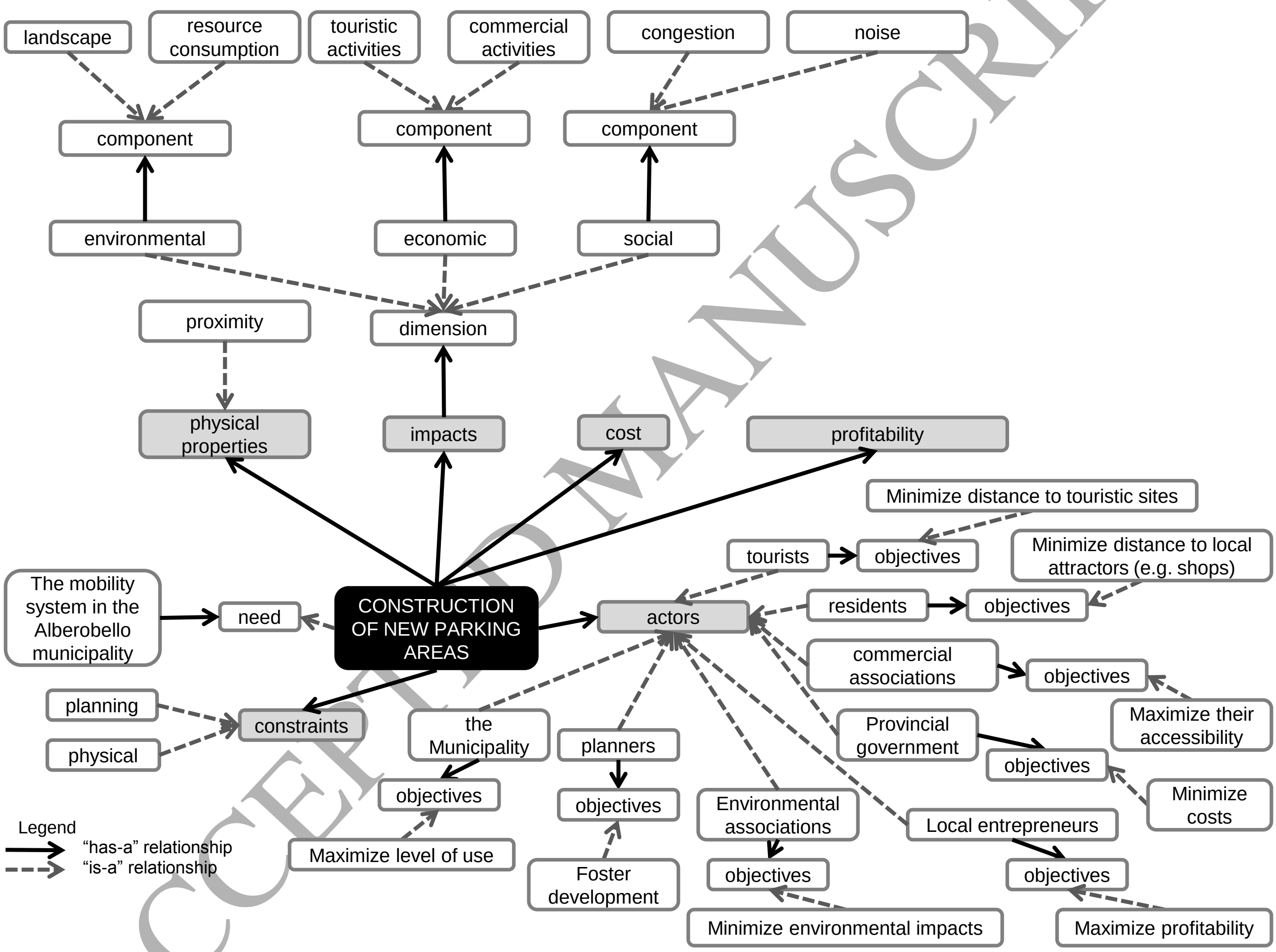

Figure 4 The simplified cognitive map developed for the problem under analysis. For the sake of the readability of the map, only the most relevant objective for each stakeholder is shown, although some of the stakeholders shared other objectives with a different degree of importance (as will be explained in section 3.2.3 and shown in Figure 9).

As shown by the legend in Figure 4, this study used the RDF3 (Resource Description Framework) triples, thus highlighting "has – a" relationships (i.e. a concept has a property) and "is-a" relationships (i.e. a concept is a value), which has shown to be a helpful tool in the context of collaborative decision support systems and semantic studies (Gordon et al., 2014). According to this approach, once the overall cognitive map is developed, it is possible to highlight the main properties of the problem, as well as to zoom into the specific values of these properties.

According to the cognitive map results, the head nodes were found to be the properties that the construction of a new parking area in an historical heritage context has, e.g. impacts, constraints, costs, physical characteristics, interested stakeholders, profitability. In particular, the objectives identified in the cognitive mapping session became the objectives in the MAVT model, thus providing specific support to the problem structuring phase of the MCDA approach, as detailed in the following paragraph.

3.2.2 Structuring

The aggregated cognitive map derived from the information gathered during the post-it brainstorming session was converted into a hierarchical structure with the fundamental objective, the involved stakeholders, their specific objectives and the related attributes.

The obtained value tree is shown in Figure 5.

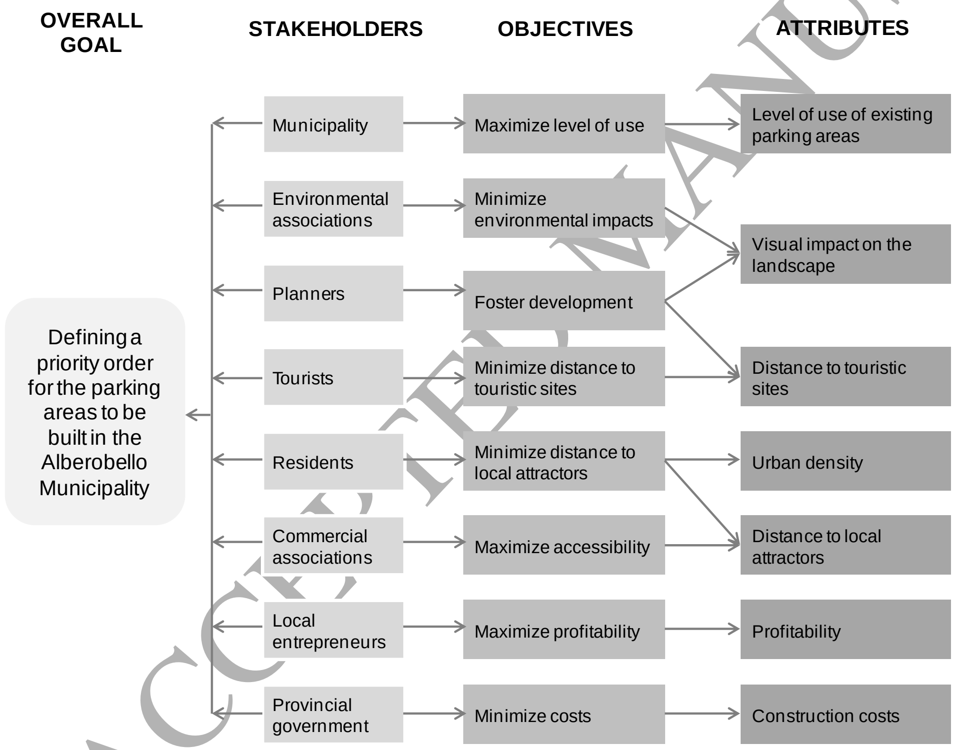

Figure 5 Value tree for the decision problem under analysis. For the sake of the readability of the value tree, only the most relevant objective for each stakeholder is shown, although some of the stakeholders shared other objectives with a different degree of importance (as will be explained in section 3.2.3 and shown in Figure 9).

In the definition of the attributes (Figure 5), we paid particular attention to the key properties highlighted by Von Winterfeldt and Edwards (1986). In particular, we seek completeness by (i) involving different perspectives in defining the problem and the objectives (Bond et al., 2008), thus avoiding the framing bias and increasing understanding and by (ii) asking questions inspired by the list of the devises proposed by Keeney (1994) to identify fundamental objectives (i.e. which would be an ideal alternative in this case and which one the worst? What needs fixing? What consequences might occur that you care about?). We seek operationality by using direct attributes as much as possible and by minimizing the use of qualitative attributes which can generate ambiguity in the model. We checked decomposability by verifying with the participants if the achievement of the overall goal of the analysis was fully explained by the achievement of its sub-objectives. Absence of redundancy has been checked by the analyst at the end of the structuring phase and the minimum size of the value tree was verified by checking with the participants that only fundamental objectives were included (i.e. asking "is this a fundamental concern or a means concern?"). We also checked the preference independence condition as explained more in detail at the end of section 3.2.3.

Moreover, in order to avoid the splitting bias, which refers to a phenomenon in which attributes or objectives receive higher weights if they are split into more detailed levels, all the objectives have been kept at the same level with no further aggregations.

Table 3 briefly describes each considered attribute while Table 4 provides the raw values of each alternative for all the considered attributes.

Table 3 Description of the considered attributes

Attribute	Description	Measurement unit	Criterion type
Level of use	The attribute evaluates the demand for new parking areas based on data collected through local surveys conducted in the winter of 2004 on the number of available slots in the existing parking areas from 9 am to 12 am. A buffer of 250 m around each alternative has been considered and the percentage of occupied slots has been calculated for each parking area. The % of occupied parking slots in the buffer around each alternative has been considered as a proxy indicator for the demand of new parking slots in the area and the attribute has thus to be maximized.	%	Maximize
Visual impact on the landscape	As is typical in a UNESCO planning context which is nowadays inspired by the Historical Urban Landscape (HUL) paradigm and requirements (SiTI, 2012), the main environmental concern associated to the type of transformation investigated in this study is the visual impact on the landscape. The attribute evaluates the nature of the visual interference of the parking areas under consideration on the surrounding landscape. This attribute is thus qualitative and is based on experts judgments.	Expert judgment	Minimize

Distance to touristic sites	The touristic sites considered for this attribute are the hotspots of the UNESCO site (i.e. “Rione Monti”, “Casa d’Amore”, “Casa Pezzolla”, “Rione Aia Piccola” and the “Trullo Sovrano”). The total walking distance (minutes) needed to cover a touristic itinerary through the five hotspots has been calculated for each alternative parking area.	Minutes	Minimize
Urban density	This attribute considers the index of territorial coverage (i.e. the ratio between the built surface and the total territorial surface) in the 250 m buffer around each alternative parking area, as well as the typologies of buildings (percentages) in the buffer.	%	Maximize
Distance to local attractors	Local attractors include the town hall, churches, the sport center, the school, the railway, the local health service and a local cooperative company. The walking distance (minutes) needed to reach each attractor from each of the 5 alternative parking area has been calculated. These values have been summed up for each alternative parking and then standardized according to the following formula $Ii = \frac{x\max - x}{x\max - x\min}$ in order to obtain a centrality index for each alternative under consideration.	Index	Maximize
Profitability	The attribute constitutes a preliminary estimate of the revenues associated to each parking area under evaluation. The annual revenue has been estimated according to the following formula (Roli et al., 2007): Annual revenue = N * E * H * D Where *N* = total number of parking slots with fee for the parking area under analysis; *E* = average fee per hour; *H* = average daily occupation of each slot; *D*= number of days in a year in which the parking has a fee. In the present study, *H* has been estimated through expert judgments based on the average percentage of occupation of each parking area in a 250 m buffer.	Euros/year	Maximize
Costs	A preliminary estimate of the construction costs has been done by multiplying the unitary construction cost (€/slot) beared in other similar projects times the total number of slots foreseen in each alternative under consideration.	Euros	Minimize

The total number of available parking slots as well as the land consumption of each parking site have not been considered as attributes because the 5 alternative sites proposed by the Municipality were all considered suitable as new parking areas and the plan of the municipality is to build more of them in the near future in order to offer to tourists and residents the appropriate number of parking slots. The interest in this initial planning phase of the process focused more on “location” aspects rather than on the total number of available parking slots and this is a typical feature of a planning process in a UNESCO site, which is characterized by more planning constraints than all other contexts (SiTI, 2012).

Table 4 Attribute levels of the alternatives

	Profitability (Euros/year)	Level of use (%)	Costs (Euros)	Urban density (%)	Distance to local attractors (index)	Distance to touristic sites (minutes)	Visual Impact on the landscape (expert judgment)
Alternative 1	351,000	100	198,920	0.079	0	22	Not significant
Alternative 2	0	55	118,026	0.304	0.34	22	Negative
Alternative 3	0	64	61,002	0.168	0.38	19	Negative
Alternative 4	312,000	60	600,000	0.161	1	17	Positive
Alternative 5	603,720	30	342,143	0.090	0.38	21	Not significant

3.2.3 Preference elicitation

The preference elicitation phase consists in (i) the construction of marginal value functions, to quantify the fulfillment of objectives in dependence of the attribute levels, and (ii) the determination of the level of trade-offs among them, to obtain a sound final ranking of alternatives. Indeed, these steps are the most cognitive demanding in the whole process, as well as the most inherently subjective.

Due to these reasons, in the present work, the technique of the focus group has been used in order to bring together experts with different backgrounds and thus ensure an inclusive and holistic perspective on the problem under analysis.

Focus groups with expert panels improve the knowledge of the scientific team on the different dimensions of the problem at hand, but, since they do not involve a representative sample of population, they cannot be used for deriving consistent conclusions on social preferences (Munda, 2004).

In this study, the preference elicitation phase consisted in the following two distinctive sub-tasks (i.e. decomposed scaling approach, Beinat, 1997): the marginal value function construction and the weights determination. The first task (i.e. marginal value function construction) was accomplished by means of a direct interview with experts on UNESCO sites management and mobility planning. The second task (i.e. weights determination) was accomplished by means of a half day workshop led by the author of the paper with experts and researchers from the Technical University of Turin and the SiTI research Institute in Turin (Higher Institute on Territorial Systems for Innovation, http://www.siti.polito.it/index.php?l=ENG).

Particular attention was dedicated to the panel composition in order to have the proper balance. Therefore, we involved an environmental engineer, an expert in economic evaluation, one in transportation planning and one in urban planning and sustainability assessments. Moreover, two of these participants were also experts on the territorial context under analysis given their experience in working for the Management Plan of the Alberobello UNESCO site. The reason for not having involved all the stakeholders identified in Table 2 is linked to the exploratory and experimental nature of the present study that aimed to test the usability and potential of the proposed mixed method approach for public policy making. Future developments of the research will test extended participation of stakeholders to the modeling phases illustrated in sections 3.2.3 and 3.2.4.

As far as the first task is concerned, eliciting value functions means translating the performances of the alternatives into a value score, which represents the degree to which a decision objective (or multiple decision objectives) is achieved. The value is a dimensionless score: a value of 1 indicates a high objective achievement, while a value of 0 indicates a low objective achievement. What characterizes the use of value functions is the measure of "differences of preferences" using interval scales (Bouyssou et al., 2006). Since people do not naturally express preferences and values in this way, value functions have to be estimated through a specially designed interviewing process in which the relevant judgments for the decision are organized and represented analytically. In this sense value functions are at best an approximate representation of human judgments and are constructed or produced (Beinat, 1997).

Single-attribute value functions can be elicited with different methods (e.g. Von Winterfeldt and Edwards, 1986). In this study we used the Midvalue Splitting Method (Bisection) because we wanted to explore advantages and limits of this elicitation protocol, which seems to lead to more reliable results than direct rating (Schuwirth et al., 2012) in a public policy making context.

In this study 0 and 1 on the y axis have been associated to the worst and best performance of the alternatives, respectively, on all the considered attributes. The reason for this was linked to the need to keep the cognitive burden on the participants as limited as possible.

Due to time constraints, we elicited value functions by asking the experts for the midvalue of the intervals [v=0, v=1], [v=0, v=0.5], and [v=0.5, v=1]. The midvalue of the interval [v=0.25, v=0.75] was used as consistency check. Disagreement between these intervals never occurred. Moreover, elicitation was facilitated by a graphical representation of the questions. In particular, we used each time a coordinate plane labeled with the attribute range and we interactively modified the extension of the two intervals considered in each question. The elicited midpoints were marked on the coordinate plane and were finally interpolated to a value function which was further discussed with the interviewed to stimulate the learning effect arising from graphical awareness and real time visualization of results.

Figure 6 shows an example of the graphical representation of the subsequent questions that we experimented for the elicitation of the value functions while Figure 7 shows the result of the procedure for all the considered attributes. Since the bisection technique can be applied only for quantitative attributes, direct rating was used for the "visual impact on the landscape" attribute.

A specific comment deserves the "costs" value function elicitation since the Decision Maker who was interviewed for this attribute felt more confident in using a direct rating approach and thus assigned a score to specific ranges of costs to which he could associate a clear meaning in terms of economic feasibility. In particular, all the costs below 200,000 Euros were considered acceptable by the Decision Maker because this was the available budget at the time the project began. The other ranges do not correspond to 0 because the Municipality, being a UNESCO site, can benefit from European funding, but the higher the costs, the less likely it is to obtain them. Nevertheless, both the bisection elicitation protocol and the direct rating technique used during the interview with the Decision Maker were considered highly cognitive demanding. A possible reason for this is linked to the very high costs under consideration in the present study, which generated very abstract questions for both elicitation protocols.

Crucial parts of elicitation were consistency checks (see Figure 10) and some training to avoid the goal-directed bias (e.g. Martin et al., 2000) which leads the interviewees to consider the midvalue point close to the preferred endpoint because they tend not to focus on improvements, but, rather, on final outcomes.

As a result of the value function elicitation procedure, the performance matrix of the alternatives under consideration has been built (Table 5).

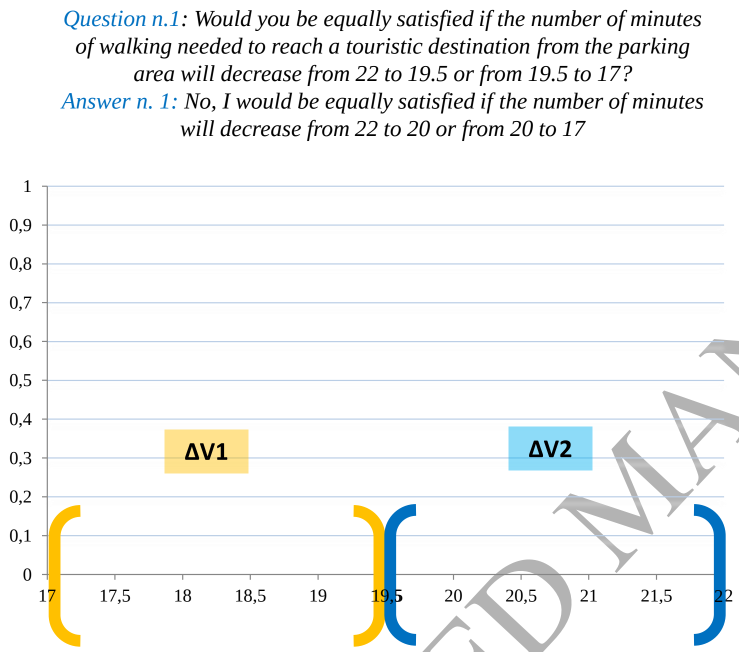

Figure 6 Graphical representation of the first question used to elicit the midvalue splitting point for the attribute “Distance to touristic sites”

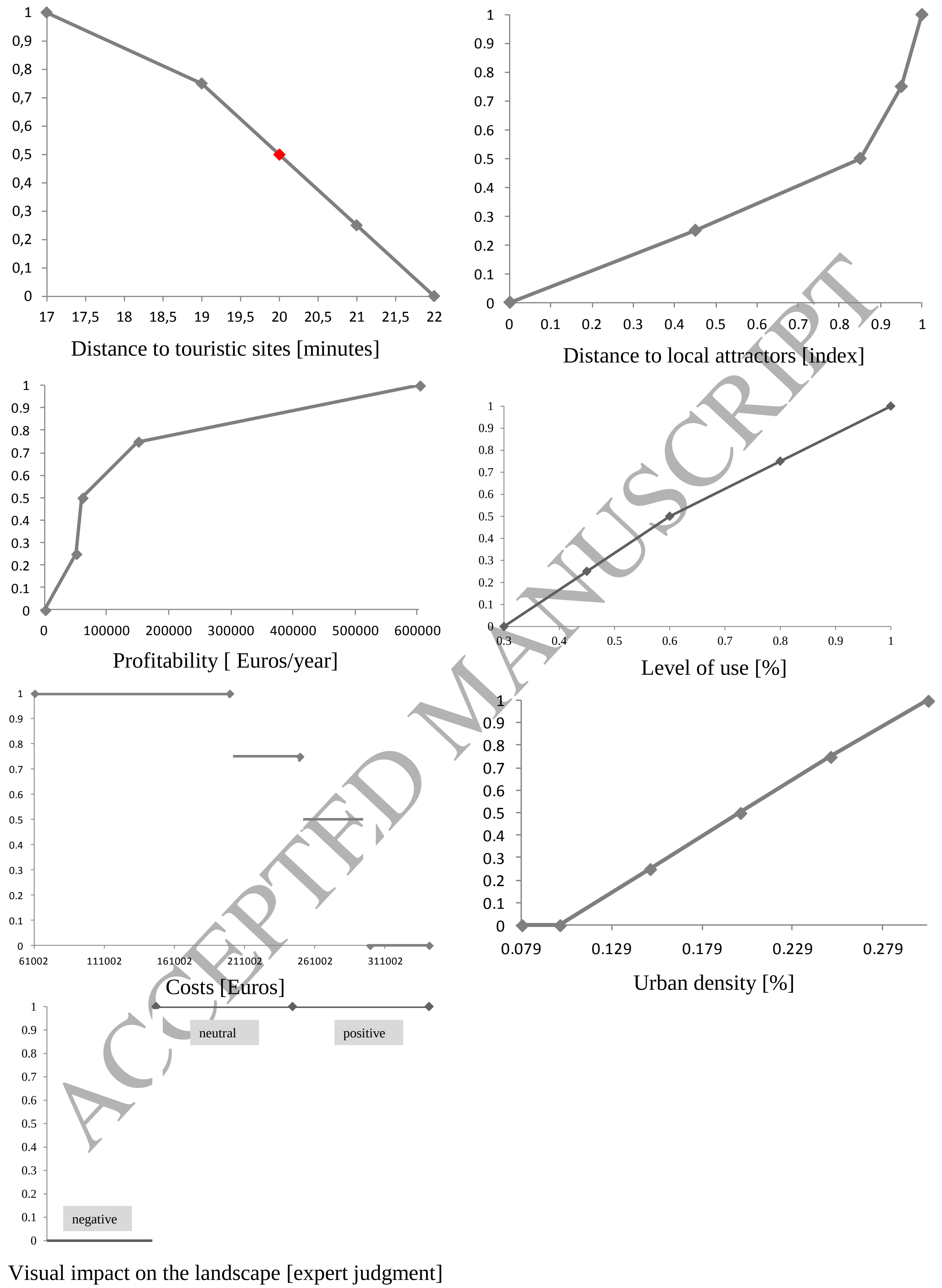

Figure 7 Final value functions for all the attributes (the red mark on the first value function is the result of the first question illustrated in Figure 6)

3.2.4 Evaluation of alternatives

As can be seen in Table 5, there is no alternative that performs as the best on all the considered attributes. It is therefore necessary to proceed with the determination of the levels of trade-offs among the attributes.

Table 5 Standardized performance table

	Profitability	Level of use	Costs	Urban density	Distance to local attractors	Distance to touristic sites	Visual Impact on the landscape
Alternative 1	0.895	1.000	1.000	0.000	0.000	0.000	1.000
Alternative 2	0.000	0.417	1.000	1.000	0.189	0.000	0.000
Alternative 3	0.000	0.563	1.000	0.340	0.211	0.750	0.000
Alternative 4	0.879	0.500	0.000	0.300	1.000	1.000	1.000
Alternative 5	1.000	0.000	0.000	0.000	0.211	0.250	1.000

In MAVT weights reflect trade-offs over the ranges of values under consideration for each attribute. This implies that weights for use in an additive model are scaling constants and need to reflect the importance of the "swing" from worst to best outcomes under consideration (Beinat, 1997).

As for the elicitation of value functions, different techniques are available for the assessment of weights (e.g. swing weights, rating, pairwise comparison, trade-off, qualitative translation) which are then used explicitly to aggregate attributes' specific scores.

Among the aforementioned approaches, one of the most used methods for eliciting weights in MAVT is the swing-weights procedure, which explicitly incorporates the attribute ranges in the elicitation question. The swing weight procedure is only appropriate for the additive value model (step 6 in section 2.3) and asks to value each improvement from the lowest to the highest level of each attribute by using a reference state in which all attributes are at their worst level and asking the interviewees to assign points to states in which one attribute at a time moves to the best state. The weights are then proportional to these points. One of the most important advantages of the Swing method is that it only requires to know the attribute ranges and is thus independent from the shape of the value functions. On the other hand, the disadvantages are that the technique is based on direct rating, it does not include consistency checks, and the extreme outcomes to be compared may not correspond to a realistic alternative, which makes the questions difficult to answer (Schuwirth et al., 2012).

In this study, a half day workshop was dedicated to the weights elicitation step. Since in a collaborative decision process it is more difficult for the experts to agree on which attribute they would like to swing first and on which score to give to that specific swing (Ferretti and Comino, 2015), in this work each expert has been interviewed separately by means of a specific questionnaire. In order to provide an example, Figure 8 illustrates the questionnaire filled in by the expert in the economic evaluation field while Figure 9 summarizes the overall set of weights elicited from the whole panel of experts.

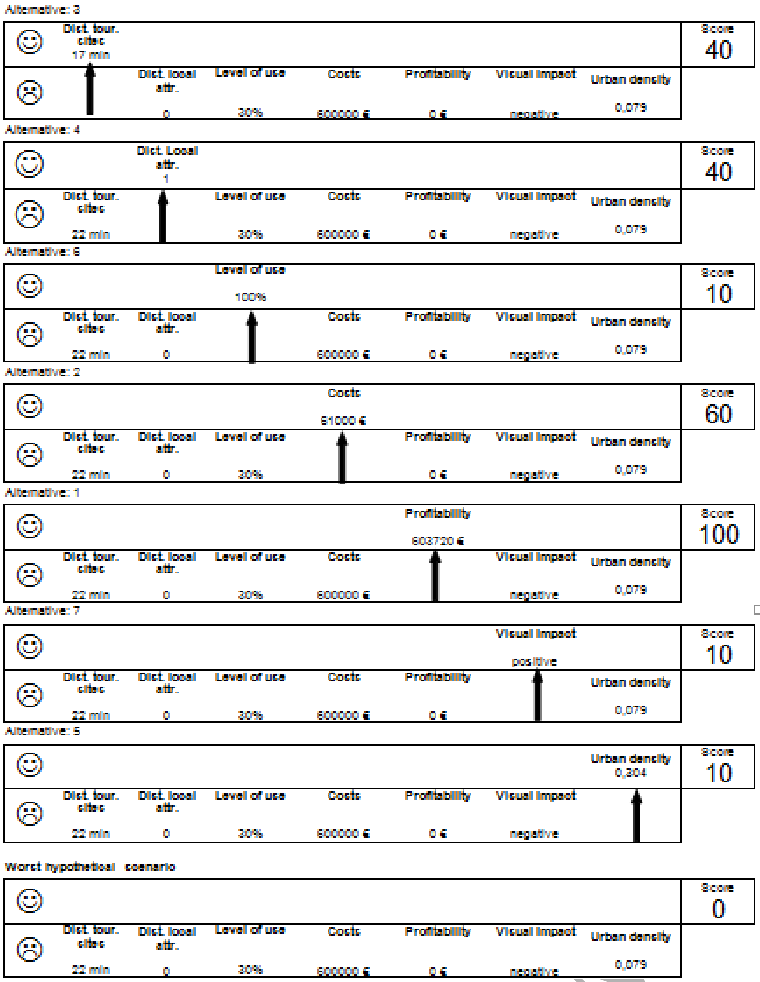

Figure 8 The questionnaire filled in by the expert in the field of "economic evaluation"

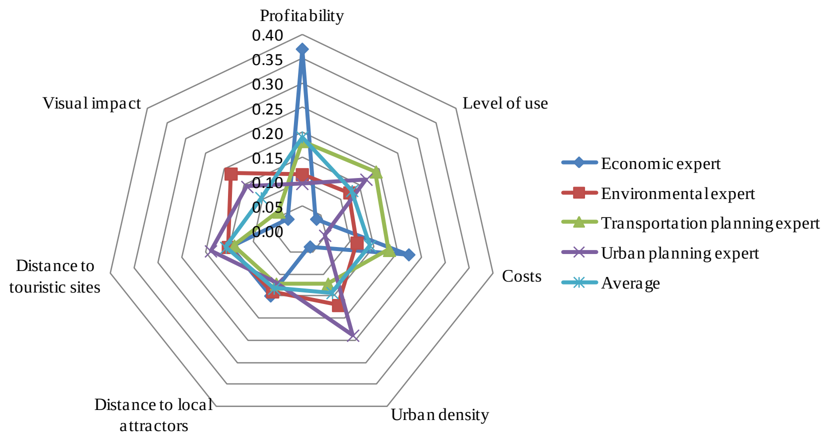

Figure 9 Schematic representation of the different perspectives of the experts on the relative importance of the attributes

As it is possible to see from the radar diagram in Figure 9, the weights set by the different experts varied considerably, thus reflecting the participants' specific expertise. This was expected, since the weights reflect each person's individual values and attitudes, personal and professional history, education, cultural background, knowledge level, the stakeholder group he/she represents, etc.

After the elicitation of the weights, we carried out consistency checks with specific trade-off questions for the two most important attributes according to each expert. In particular, we confronted the interviewee with two hypothetical outcomes that should be equally good (or bad) according to the elicited weights and value functions (Schurwith et al., 2012). We asked for indifference between the two outcomes and inconsistencies never occurred.

In order to provide an example, Figure 10 represents the questionnaire that was used for the consistency check of the most important attributes with the expert in the field "economic evaluation". As a result of the consistency check, the value trade-offs were validated.

Consistency check with trade-off		Interviewee	
		Expert in the field of economic analysis	
Alternative 1		**Alternative 2**	
Objective a	**Objective b**	**Objective a**	**Objective b**
☺ Costs	☹ Profitability	☹ Costs	☺ Profitability
V_{c1}=1 (Costs: 61,000 €)	V_{p1}=0 (Profitability: 0 €/year)	V_{c2}=0 (Costs: 300,000 €)	$V_{p2}=w_c/w_p$=0,6 (Profitability: 96,000€/year)

➡ Do you think both alternatives are equally good (or bad), or one of the alternatives is better than the other?
✓ both are equally good (bad)
❑ alt 1 is better
❑ alt 2 is better

➡ If one of the alternatives is preferred, how to adjust v_{p2} that alternative 1 and 2 are equal?
…

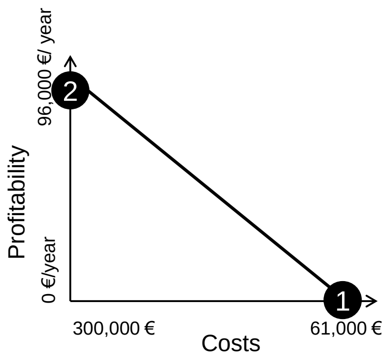

Figure 10 Elicitation tool used for the consistency check on the two most important attributes for the expert in the economic evaluation field (source: elaboration from Schurwith et al., 2012).

3.2.5 Aggregation and analysis of final results

The single attribute value functions have then been aggregated using the obtained set of weights and additive assumptions to calculate the total value of the specific alternatives. Additive aggregation implies that a low value on one attribute can be compensated by large values on other attributes. Therefore, this aggregation technique must fulfill relatively strong independence conditions (Keeney and Raiffa, 1976) which must be verified in each case.

According to Dyer and Sarin (1979) the conditions to be validated to define measurable additive value functions are mutual preferential independence, difference consistency and difference independence. The methodology used to test them was to interview the experts through specific questionnaires related to the two most important attributes for each expert. The reason for testing the three conditions only on the two most important attributes for each expert is linked to the need to keep the cognitive and time burden on the experts participating in the focus group as limited as possible.

For instance, the preferential independence (condition 1) of attribute 1 (*Profitability*) with respect to all the other attributes was tested by asking the expert in the economic analysis field to express a preference (or indifference) relation between two hypothetical alternatives where only $x1$ was varied, with all the other attributes fixed. Next, the level of one attribute i initially fixed, was changed and the expert was asked to compare the new set of alternatives arising from varying also $x1$ into three levels (high, low and middle). A decision maker is preferentially independent regarding $x1$ when the preferential relations elicited are independent of its level. The procedure was repeated for three levels of the two most important attributes, by changing the level of each other attribute, one at a time (as shown in Duarte and Reis, 2006). The procedure, although time and effort consuming for the participants, revealed that the panel was preferentially independent with respect to the most important attributes.

The difference consistency (condition 2) was checked by asking the panel to set the preference relation between two alternatives, Alt 1 and Alt 2, respectively, with all attributes equal except one (i.e. attribute i). Then, the experts were asked to set the preference relation between those two alternatives and a third one, Alt3, which was built from Alt1 by reducing the value of attribute i to a level below the lower level it had in the lottery {Alt1, Alt2}. Next, the experts were asked to indicate the preference relation between the strength of the choice of Alt1 within the pair {Alt1, Alt3} and of Alt2 within the pair {Alt2, Alt3} (Duarte and Reis, 2006). The assessment of such a condition was based on the two most important attributes for each expert, which were changed between their worst and best levels. The difference consistency condition was validated since the panel revealed a preference for the alternative involving the project chosen from the first lottery {Alt1, Alt2} in all the comparisons. That is, if the expert prefers Alt1 to Alt2 in judging the pair {Alt1, Alt2}, the strength of choice of Alt1 from the pair {Alt1, Alt3} is higher than the strength of choice of Alt2 from {Alt2, Alt3}.

The test of difference independence was also based on the elicitation of a preference relation between two projects, Alt1 and Alt2, with only one of the attributes varied at a time. Afterward, a third and fourth project, called Alt3 and Alt4, respectively, were presented to the single experts. Alt3 was built from Alt1 and Alt4 from Alt2 by changing one of the initially fixed attributes to a lower level. Next, the experts were asked to set the preference relation for the pair {Alt1, Alt3} and {Alt2, Alt4} and to compare the strength of the choice of Alt1 from the pair {Alt1, Alt3} with the strength of the choice of Alt2 from the pair {Alt2, Alt4}.

The two most important attributes that were changed in the pair {Alt1, Alt2} were varied at three levels (high, low and medium). All the experts revealed difference independence regarding the most important attributes.

It is worth mentioning that the possibility of accurately testing the 3 above mentioned conditions is strongly linked to the fact that we used an expert panel for the elicitation of preferences and trade-offs. The same operation would have been much more complicated in a more extended participative setting open to non-experts participation. The reader interested in knowing more about how to develop the independence conditions checks can refer to the interface proposed by Duarte and Reis (2006).

Once the conditions above were validated, the application of formula (1) provided the final priorities presented in Table 6.

Table 6 Overall evaluation of the alternatives for the different experts

	Economy		Environment		Transportation		Urban planning	
Alternatives	Final score	Ranking	Final score	Ranking	Final score	Ranking	Final score	Ranking
Alternative 1	0.63	**2**	0.53	**2**	0.60	**2**	0.44	**2**
Alternative 2	0.30	5	0.36	5	0.26	5	0.38	4
Alternative 3	0.40	4	0.39	3	0.46	3	0.39	3
Alternative 4	0.69	**1**	0.69	**1**	0.62	**1**	0.69	**1**
Alternative 5	0.48	3	0.37	4	0.30	4	0.31	5

From Table 6 it is possible to notice that alternative 4 is the best option for all the experts and that alternative 1 is the second best option again for all the experts. The stability of the first two options, despite the different points of view considered in the analysis, suggests that in the short term resources should be allocated toward the construction of these two options. In particular, alternative 4 considers an area that represents a strategic interchange pole for the municipality of Alberobello. This pole will respond to both a residential demand for new parking areas (Aia Piccola neighborhood) as well as to touristic demands since it is located very near the train station. It is interesting to notice that the analysis based on an integrated decision aiding approach allowed the decision maker to learn from the set of values being considered and to better understand the synergies existing among the alternatives. As a matter of fact, when confronted with the final results the Decision Maker discovered a new interesting alternative consisting in the creation of a network of parking areas where buses could bring the tourists (i.e. alternative 1), then park in areas that are less interesting from the panoramic point of view (i.e. alternative 4) and then take again the tourist at the end of their touristic visit (i.e. alternative 3). This will ensure a more efficient mobility management.

The generation of this new alternative shows how the use of prescriptive decision analysis and participatory problem structuring can lead to the design of new consensus alternatives in a real decision making process. This is particularly interesting since the design of alternatives has recently gained attention in the scientific literature (Colorni and Tsoukiàs, 2013) and there is a need for testing different tools in order to support innovative design of better alternatives. The mixed method approach proposed in this paper thus helped the participants to generate a new consensus alternative at the end of the process. Despite the costs of the new alternative being above the maximum budget of the municipality, they developed an action plan in order to apply for UNESCO funding in order to be able to implement this new solution, which generated overwhelming agreement among the local stakeholders.

3.2.6 Sensitivity analysis on the weights

The final step of the study consisted in a sensitivity analysis to test the stability of the results. The One-at-a-Time (OAT) approach (Daniel, 1973) has been used meaning that the weight of one attribute at a time has been increased to 0.70 while keeping all the others equal to 0.05 in order to observe the effects on the final results. As it is possible to see from Figure 11, Alternative 4 remains the best option in 4 scenarios out of 7, is the second best option in 2 scenarios and is the fourth position of the ranking in one scenario only. Alternative 1 is the first or second best position in 4 scenarios out of 7 and is at the end of the ranking in the remaining scenarios.

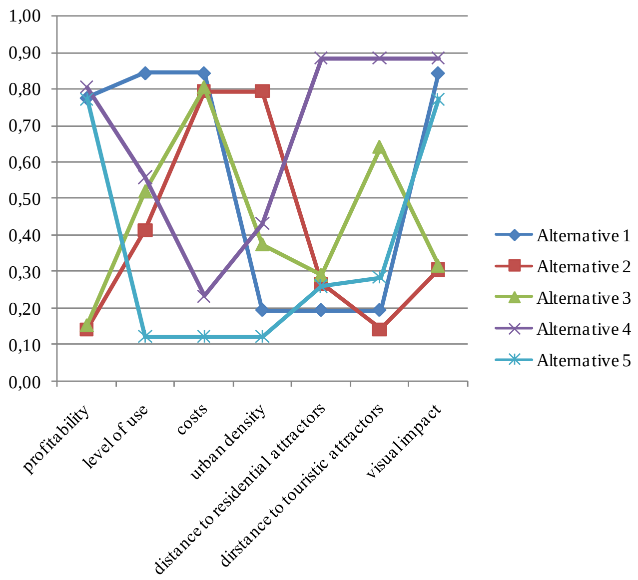

Figure 11 Sensitivity analysis results

The final results of the analysis have been shown to the real decision makers in the Alberobello municipality who noticed the coherence with the expected results and the planning regulation. The variability of the results in the sensitivity analysis allowed the decision makers to get deeper awareness about the most critical attributes, i.e. those which can cause an inversion in the final ranking.

Other sources of uncertainty with which sensitivity analysis is concerned refer to the values of the bisection points, the choice of the aggregation function, and the attribute levels. While uncertainty on the bisection points and the aggregation function will be investigated as part of the future developments of the present research, Table 7 compares the outcome of the ranking obtained in the present study (i.e. with non-linear value functions) with that obtained assuming linear value functions for all the attributes (which is the common practice in most MCDA real applications).

Table 7 Sensitivity results with respect to linear versus non-linear value functions in the present study (the numbers in bold refer to the ranking of the alternatives)

	Economy		Environment		Transportation		Urban planning	
Alternatives	Linear	Non linear	Linear	Non linear	Linear	Non linear	Linear	Non linear
Alternative 1	0.43 **(3)**	0.63 **(2)**	0.37 **(4)**	0.53 **(2)**	0.46 **(3)**	0.60 **(2)**	0.33 **(3)**	0.44 **(2)**
Alternative 2	0.31 **(5)**	0.30 **(5)**	0.39 **(3)**	0.36 **(5)**	0.27 **(5)**	0.26 **(5)**	0.41 **(2)**	0.38 **(4)**
Alternative 3	0.41 **(4)**	0.40 **(4)**	0.41 **(2)**	0.39 **(3)**	0.48 **(2)**	0.46 **(3)**	0.41 **(2)**	0.39 **(3)**
Alternative 4	0.56 **(2)**	0.69 **(1)**	0.67 **(1)**	0.69 **(1)**	0.58 **(1)**	0.62 **(1)**	0.69 **(1)**	0.69 **(1)**
Alternative 5	0.58 **(1)**	0.48 **(3)**	0.35 **(5)**	0.37 **(4)**	0.38 **(4)**	0.30 **(4)**	0.28 **(4)**	0.31 **(5)**

It is interesting to notice that results are sensitive to the shape of the value functions (Stewart, 1996). In this study in particular we can see that, assuming linear value functions in place of those elicited from the experts, Alternative 4 remains the first one in the ranking 3 times out of 4 and only in one case is ranked as second best, while Alternative 1 and Alternative 3 see an overall worsening/ improvement of their performances, respectively. In general, we can also observe that the ranking obtained with the non-linear value functions elicited from the experts seems more stable across the different perspectives, while the one assuming linear value functions is characterized by greater variability in the different rankings.

4. Discussion and conclusion

The complexity of contemporary public policies consists of the plurality and heterogeneity of the points of view represented within a policy making process (Dente, 2014).

This paper combined decision making support and participatory procedures through an approach that integrates stakeholders analysis, cognitive mapping and multicriteria evaluation for the prioritization of new parking areas in a UNESCO site.

The paper showed how evidence from cognitive mapping analysis can be translated into multiple criteria decision analysis by the means of value trees of stakeholders objectives.

The aim of this section is to shed some light on the overall evaluation process through the analysis of the feedback received during the focus group sessions in order to provide guidelines for policy design and future applications.

With reference to the first tool used in the proposed process, i.e. stakeholders analysis, the experts participating in the focus group recognized the ability of the tool to enable the same understanding of the problem, increase the traceability and transparency of the overall decision process and allow relevant issues to be taken into account since the very beginning of the process.

With reference to the second tool used in the proposed process, i.e. cognitive mapping, the overall map connecting concepts and objectives was quite appealing and highly intuitive to all of them as an organizing concept that captures their objectives and values. The process of cognitive mapping in general seemed an excellent vehicle for drawing out knowledge and ideas from the participants and the interactive setting of the focus groups fostered creativity and provided additional means of decision legitimacy by ensuring transparency and participation (as shown also in Kpoumié et al., 2013). Moreover, the cognitive mapping tool, along with value focused thinking principles (Keeney, 1992), helped guide the development of the value tree.

Despite the advantages of the use of cognitive mapping in the decision support process, the study also noted the following critical aspects. First, facilitation and participation are key to developing a good and adequate cognitive map that captures the values and perceptions of the participants. In this study, a participatory and facilitated (Franco and Montibeller, 2010) cognitive map formation process was adopted. But there is a fine line between structured facilitation, and "facipulation" (i.e. manipulative facilitation), which is likely prone to confirmation bias (Mendoza and Prabhu, 2009). No attempt was made to add or subtract from the ideas contributed by the participants. An effort was also made in order to have a participative procedure with both experts and non-technical experts in order not to disregard any important parameter.

With reference to the third tool applied in the proposed process, i.e. MAVT, the following advantages have been highlighted. To start with, the procedure generates not only a ranking of decision options, but also the relative global performance of every alternative under analysis. The transparency of the procedure makes it more difficult to influence results with a hidden agenda than with unstructured negotiation processes. Moreover, it is simple in application and it does not require sophisticated software. Probably, the most important advantage of the method lies in the learning effect that it generates. Since people do not naturally express preferences and values with value functions, these have to be estimated through a specially designed interviewing process in which the relevant judgments for the decision are organized and represented analytically. In this sense value functions are at best an approximate representation of human judgments and are constructed or produced (Beinat, 1997). They are not already available in our mind, therefore there is a true learning effect. Another great strength of the MAVT approach is that it can deal with a large number of alternatives without an increase of the elicitation effort compared to a study with a smaller number of alternatives. This is due to the fact that value functions are elicited from the Decision Maker or stakeholder independently of the alternatives, based on his or her preferences about the fulfilment of the different objectives. The preference elicitation step is indeed based simply on the range of variation of each attribute over all alternatives, i.e., the best- and worst- possible level of each attribute. Therefore, any additional alternative can be introduced at a later stage as long as the extreme levels of its attributes stay within the ranges defined for preferences elicitation (Schuwirth et al., 2012). However, eliciting value functions for complex decisions with many objectives is intellectually challenging and time consuming. Policy stakeholders usually have very limited time, and it may be necessary to simplify the elicitation task or make it more realistic.

Another drawback of the adopted approach is that all the attributes have to be defined on a common scale through the above mentioned value functions in order to compare alternatives on different aspects. This is a strong requirement for this methodology.

An issue worth being discussed relates to the insurgence of disagreement and divergent views throughout the decision process. The facilitated decision making process adopted in this study together with the choice of specific experts participating in the focus groups allowed participants to question perceptions and learn from each other expertise. Two moments in particular where characterized by disagreement: the first one happened during the construction of the cognitive map presented in section 3.2.1, while the second one happened during the weights elicitation procedure presented in section 3.2.3. While during the cognitive map construction the consensus was achieved by allowing each participant to explicit his/her objectives and subsequently taking them into account in the modelling of the problem, the achievement of a consensus in the weights elicitation phase has been more challenging. As it usually happens in complex environmental decision making contexts, it is almost impossible to reach a consensus when adopting the swing weights procedure in a group decision making context (e.g. Ferretti and Comino, 2015), i.e. it is really difficult than more than one participant agree not only on which attribute to swing first from the worst performance level to the best performance level but also on the value to give to that swing from 0 to 100. The solution that we adopted in this study was thus to propose individual questionnaires to the involved participants in order to be able to elicit their preferences and aggregate them in a second moment.

Overall, the three tools integrated in the proposed process showed to benefit from synergistic effects.

A limitation of the work refers to the availability of updated data concerning the level of use of the existing parking areas.

The future developments of the study will follow two directions. The first refers to the investigation of the stability of the results with reference to other sources of uncertainty, i.e. the bisection points, the attribute values and the end points of the value functions (i.e. the relative minimum and maximum performance score values or the absolute ones) (Steele et al., 2009). The second refers to the possibility to move from a sequential design of mixed methods (Morse and Niehous, 2009; Creswell and Plano Clark, 2011) to the hybridization of mixed methods by a further integration of steps and inputs and outputs from one method to the other in order to generate analytics innovation. For instance, in the proposed process, the results of the stakehodlers analysis (i.e. the quantitative power/interest matrix) could be interpreted as importance scores of each stakeholder category and used to aggregate the MAVT results according to the different perspectives rather than by a simple average.

In conclusion, the contribution highlighted that in complex decision-making problems what really matters is the decision-making process because a computation can never replace the decision and the mechanical application of any model is always somewhat arbitrary in weighting the importance of the various criteria and inaccurate in the evaluation of the consequences.

4.1 Operability of the proposed approach

This section reviews the overall developed process by discussing its operability according to 3 specific dimensions, i.e. transparency, consensus building and applicability.

Transparency. Besides clarity and openness, the participants acknowledged that they were able to understand the purpose and the reasoning behind the process, that they became aware of both the positive and the negative aspects associated to the decision problem and that they learned from the justifications provided by the other participants.

Consensus building. Different perceptions were acknowledged throughout the process thanks to the involvement of multiple stakeholders and experts. Moreover, stakeholders were engaged since the very beginning of the process and this helped to reach a consensus and to develop a sense of ownership of the problem as well as of the solution.

Applicability. The developed process resulted to be highly operable since its results have effectively helped the decision maker not only to identify the best alternative among the initial set of suitable sites but also to generate a new optimal alternative based on the combination of the options performing best on the most strategic criteria. The process was thus judged successful by the involved stakeholders because it lead to an action plan for implementing the recommendation. The availability of quantitative criteria and the development of the sensitivity analysis were also interpreted to enhance operability. Finally, the possibility of using the outputs of a method as inputs to the subsequent method in the sequential design of the process without the need of specific software for the conversion of the data assured interoperability to the whole process.

In conclusion, the strongest benefits associated to the mixed methods approach experimented in this study can be summarized as follows: (i) the ability to detect and solve possible critical/conflicting issues at the very beginning of the planning process rather than at the end; (ii) the capacity to link outputs and inputs from one method to the other in a transparent way which grounds the results on a shared understanding and structuring of the problem and (iii) the collective learning effect that it generated.

Nevertheless, despite the various benefits highlighted above, there are also several challenges involved in the development of mixed methods in real world decision contexts. As this successful case illustrates, the application of mixed methods can be a very time-consuming and demanding task. Moreover, facilitators skilled in multiple methods are not easily available.

The main limitations of this study can be summarized as follows: firstly, in a collaborative decision making context, the MAVT approach does not easily support the inclusion of divergent views during the weight elicitation process (e.g. Ferretti and Comino, 2015), thus calling for the need to individually interview the participants and then aggregate their preferences. Secondly, the inclusion of multiple real stakeholders during the preliminary cognitive mapping process and the need to keep the cognitive burden at a manageable level during the process allowed us to develop a simplified cognitive map with respect to the original one proposed by Eden (1988). Finally, the number of real stakeholders involved in the process might be considered relatively small. The reason for this last issue is linked to the exploratory and experimental nature of the present study that aimed to test the usability and potential of the proposed mixed method approach for public policy making. As a matter of fact a wider involvement of stakeholder could better ensure that all the relevant concerns and objectives are included in the analysis since the very beginning of the process. On the other hand, its main drawback refers to the dilution of expertise and power among the group, which might make it difficult to reach an agreement and implement the chosen solution (Phillips, 2007).

4.2 Policy implications: innovative design of strategic options

Very recent international trends have recognized that a new challenge for policy making and decision theory refers to the design of alternative options (Tsoukiàs et al., 2013). Indeed, no matter how good the evaluation is, if all the options under analysis are bad, the result will be a bad option. With reference to this point, the use of the mixed method approach proposed in the present process seemed to help stimulate the process of creating new options that are acceptable to all (see the last part of section 3.2.4).

As the discussion focuses on valuing objectives rather than directly on alternatives, the procedure facilitates appreciating other perspectives and opens the horizon for new consensus-alternatives since reasons for good or bad performance of alternatives are revealed, and new alternatives can easily be included in the analysis a posteriori (Schuwirth et al., 2012).

Other methods that the author is testing and considers particularly promising for supporting the design of alternatives are:

(i) spatial multicriteria evaluation (Malczewski, 2006) because, by using and overlaying spatial maps for each indicator it allows to discover suitable areas for the location of a new object (i.e. areas with concentration of high scores across adjacent cells) and unsuitable areas (i.e. areas with concentration of low scores across adjacent cells). This tool can therefore support the design of new alternatives and plays a crucial role in the strategic and macro-localization planning phase (e.g. Ferretti, 2011; Comino and Ferretti, 2016).

(ii) Choice-based conjoint analysis (Lancaster, 1966) because by decomposing a good or service into attributes with different levels and asking users to choose between different combinations of attributes' levels, it allows to discover the most important characteristics on which to focus the attention in the design of the new product or service (e.g. Ferretti and Gandino, 2016).

(iii) Value-focused thinking design (Keeney, 1996) because focusing on the values that should be guiding the decision situation removes the anchor on narrowly defined alternatives and makes the search for new alternatives a creative and productive exercise. This will allow to highlight the potentialities of this step for leading towards better policy design and more sustainable decision alternatives.

In conclusion, I hope to stimulate the use of collaborative decision support processes to deal with other complex public policy problems.

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