Journal of Infrastructure, Policy and Development 2024, 8(9), 7641.
https://doi.org/10.24294/jipd.v8i9.7641

Article

Transport infrastructure: Adaptive choice modelling for deliberative appraisal judgments

Saverio Miccoli, Rocco Murro*

Department of Civil, Building and Environmental Engineering, La Sapienza University of Rome, Via Eudossiana 18, 00184 Rome, Italy
*** Corresponding author:** Rocco Murro, rocco.murro@uniroma1.it

CITATION

Miccoli S, Murro R. (2024). Transport infrastructure: Adaptive choice modelling for deliberative appraisal judgments. Journal of Infrastructure, Policy and Development. 8(9): 7641. https://doi.org/10.24294/jipd.v8i9.7641

ARTICLE INFO

Received: 1 July 2024
Accepted: 1 August 2024
Available online: 9 September 2024

Abstract: Political representation is responsible for choices regarding the supply and the management of transport infrastructure, but its decisions are sometimes in conflict with the will and the general interest expressed by citizens. This situation has progressively prompted the use of specific corrective measures in order to obtain socially sustainable decisions, such as the deliberative procedures for the appraisal of public goods. The standard Stated Choice Modelling Technique (SCMT) can be used to estimate the community appreciation for public goods such as transport infrastructure; but the application of the SCMT in its standard form would be inadequate to provide an estimation that expresses the general interest of the affected community. Hence the need to adapt the standard SCMT on the basis of the operational conditions imposed by deliberative appraisal procedures. Therefore, the general aim of the paper is to outline the basic conditions on which a modified SCMT with deliberative procedure can be set up. Firstly, the elements of the standard SCMT on which to make the necessary adjustments are identified; subsequently, modifications and additions to make to the standard technique are indicated; finally, the contents of an extensive program of experimentation are outlined.

Keywords: transport infrastructure appraisal; community assessment; inclusive appraisal; civic appraisal; deliberative appraisal judgments; stated preference techniques; adaptive stated choice modelling techniques

1. Introduction

The paper draws its motivation from the importance that the communities place on public goods, in a general sense, and on transport infrastructure, in particular. Hence the intention of citizens to be directly involved in decision-making processes regarding these goods. The worsening of the crisis and the inequalities produced by the current economic system over the last few decades have significantly reduced, in large sections of the population, the possibilities of satisfying with their own resources certain basic needs and aspirations that the evolution of society has now raised to the rank of legitimate necessities.

Political representation makes its own decisions for the provision and management of transportation infrastructure. But its decisions are often deemed inadequate, or sometimes even in conflict, with the will and general interest expressed by citizens. This situation has progressively prompted the research and use of specific corrective measures in the public decision-making process, with the intention of directly involving citizens in decisions that, in any case, affect them and of which they are the beneficiaries. Among the corrective measures introduced, it is worth mentioning the deliberative procedures for appraisal judgements on the monetary value of public goods, because of the consensus that they are able to bring to the choice

of policies and investments related to them, in order to produce socially sustainable decisions.

The standard Stated Choice Modelling Technique (SCMT) makes it possible to identify, from a set of alternative configurations of the good, the most likely to be chosen by consumers on the market. This possibility, offered by the technique in the exchange of private goods with a market price, does not exist for public goods without market, which are related, conversely, to recognition of importance or to non-exclusive or non-rival conditions of use. For these goods it is only possible to measure the Willingness To Pay (WTP) according to the economic aspect to be considered, stated by the citizens affected by them. Hence the need to adapt the standard SCMT, on the basis of the operational conditions imposed by deliberative appraisal procedures.

Therefore, the general aim of the paper is to outline the criteria and the basic conditions on which a modified SCMT can be set up, fully applicable to the issue of transport infrastructure. The specific objectives consist: a) in identifying, on a preliminary basis, the areas and points of the standard SCMT on which to make the necessary adjustments; b) subsequently, in indicating which modifications and additions to make to the standard technique; c) finally, in outlining the contents of an extensive program of experimentation, in the laboratory and in the field, necessary to define the operative proposition of an adaptive SCMT, empirically validated in its new connotation.

In order to achieve the aforementioned objectives, it was necessary to collect, catalogue and study the main scientific contributions available in the literature on standard SCMT, an endeavor that led to the acquisition of an in-depth knowledge of the technique to be adapted. Theoretical documentation and relevant international experiences on deliberative decision-making procedures, both generalized and specific to the field of appraisal, were then researched and analyzed.

The paper is structured as follows. In Section 2, the general aspects of the standard SCMT and the characteristics of deliberative appraisal judgements of transport infrastructure, on the basis of the literature review, are described and discussed. In Section 3, after identifying the elements of the standard SCMT on which to make the necessary adjustments, proposed indications to overcome the various critical elements are illustrated. Section 4 outlines the contents of an extensive program of experimentation of the proposed procedure. Some concluding remarks are made in Section 5.

2. Materials and methods

2.1. General aspects of standard SCMT

After becoming aware of their needs and having selected the alternative goods that can satisfy them, individuals are assumed to choose the good to be consumed (and the relative quantity) according to its attributes. The good that will be preferred will be the one to which the individuals associate the highest level of satisfaction, given the attributes recognized to it. The SCMT, therefore, is based on the assumption that any good is characterized by its attributes; a change in attributes, and in their respective levels of preference, will result in a different configuration of the good.

Overcoming the postulate of traditional microeconomic theory of consumer

behavior, according to which the utility of a good derives from the properties of things, i.e., the objective characteristics it possesses, as invariant for each consumer (Lancaster, 1966, 1971; Rosen, 1974), today's approaches assume that utility, rather than from the good itself, derives from the attributes that individuals, in a subjective dimension, recognize in the good (Louviere et al., 2000; Pearce et al., 2002). Attributes are the services that the individual expects to be provided by the good according to the characteristics it possesses. An attribute or consumption service is thus related to the perception of one or more objective characteristics of the good.

The purpose of the SCMT is to identify the combination of attributes preferred by the subjects involved in a survey from a given set of alternative options. The analysis of the combined effects of the attributes makes it possible to detect their relative importance and the combination likely to be most preferred. The SCMT allows to focus on the monetary value associated with the different alternative options; it represents a fundamental attribute of the different options and a crucial datum for the estimation of the individual WTP for the good, stated by a sample of persons involved in the survey.

The first steps in the field of SCMT and in the field of choice experiments were taken by Thurstone (1927); since then SCMT has been widely studied: Luce (1959) thanks to his psychological theories on choice and utility, together with other mathematicians and psychologists, began studies to understand the way in which individuals make their decisions with respect to different alternatives; Abelson and Bradley (1954), Bradley and El-Helbawy (1976) provided design results of preference experiments involving pairs of alternatives. After these early works, only sporadic progress of this technique was made until the early 1990s, when new proposals began to proliferate (Burgess and Street, 2003; Hancock et al., 2020; Kassahun et al., 2021; Lusk and Norwood, 2005; Sándor and Wedel, 2002; Schoon and Chi, 2022; van Cranenburgh et al., 2022). Significant impacts on SCMT have also resulted from the scientific contributions of McFadden (2014) and Kahneman (1990) through the direct application of psychological theory to economics, in order to specify consumer choice behavior and identify the demand.

Based on these advances, the application of SCMT became widely established, firstly, in the fields of marketing and industrial pricing, due to their ability to analyze the relationship between the variation in the levels of the attributes of the good and its monetary value; later, in the valuation of environmental goods and services, amenities and mobility services (Changlin and Long, 2023; Hernandez et al., 2023; Hu, 2023; Saarikoski et al., 2022).

Within the operational stages of a standard SCMT (**Figure 1**), the design of the alternative options of the good to be valued is structured in two steps.

In the first stage, known as qualitative study, the relevant elements to construct the different alternative options are selected, i.e., the set of attributes with their corresponding levels. The attribute levels can be expressed through definite quantities or by indicating a range of variation. The attributes must be consistent with the purpose of the investigation, meaningful, and relevant on the monetary value associated to each alternative: the latter must always be present in the set of attributes of a given option. The attribute levels may be formulated in qualitative or quantitative scales, absolute or percentage; their number must be such as to provide essential information and favor

the clear distinction of the alternatives to be examined; since as the levels of each attribute increase the number of possible alternative options increases, in the application phase there is a tendency to limit their number.

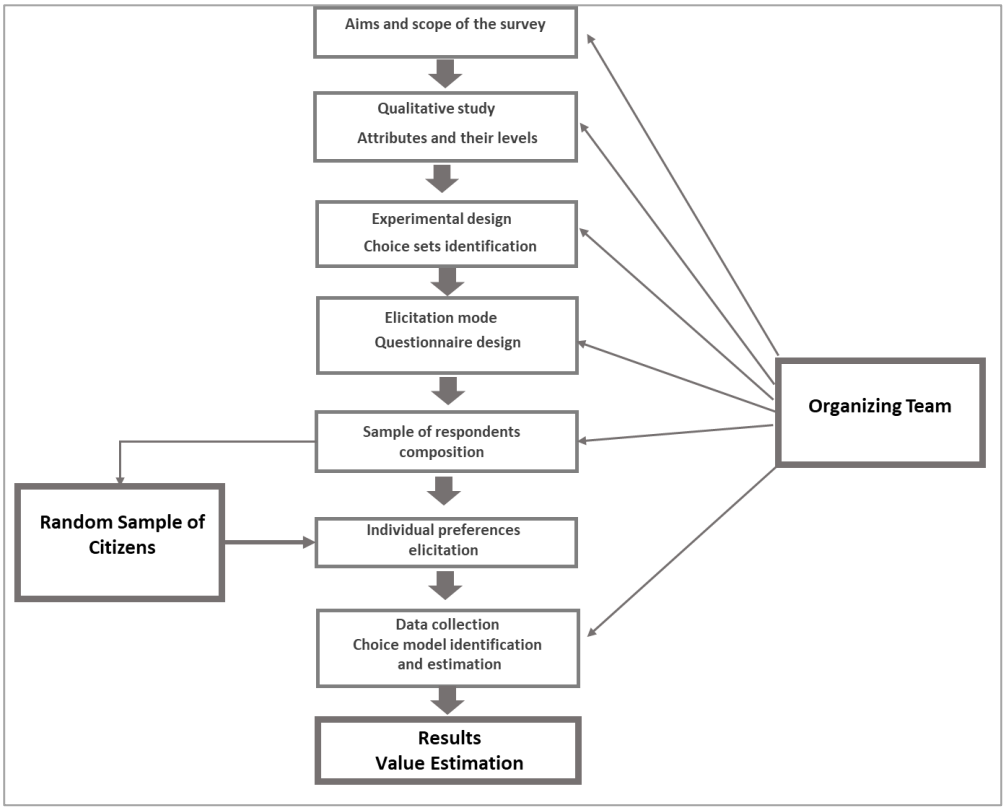

Figure 1. Operational stages of the standard stated choice modelling technique.

As part of the qualitative study, in some cases, investigations are undertaken using focus groups: a group of individuals—a maximum of ten members of the target population affected by the good to be valued—is brought together to answer questions posed by an interviewer and to exchange views, during a meeting generally lasting between 30 and 90 minutes. During the meeting, the focus group provides information on: a) the attributes of interest for the good to be valued and their respective levels; b) the maximum number of alternatives that the valuation subjects actually consider when making a choice; c) the criteria that subjects use to express their preferences.

In the second stage, known as experimental design, the different alternative options to be valued by the respondents (choice sets) are outlined, thanks also to repeated attempts at composition. Reference is made to the concept of the designed experiment, "a way of manipulating attributes and their levels to permit rigorous testing of certain hypotheses of interest" (Louviere et al., 2000). By using a complete factorial design, the various possible combinations are defined on the basis of all the attributes and levels identified; since the number of possible combinations increases exponentially with the number of attributes and levels, it would be appropriate to proceed with a fractional design, with which to select a subset of combinations from the complete factorial design; the fractional design, although limited in combinations, must nevertheless be statistically representative. In ordinary practice choice options typically not exceed 32 in number (Adamowicz and Boxall, 2001), although the ideal

range, also in order not to make the choice task difficult for the valuation subjects, should be 8–12 options (Pearce et al., 2002).

Having defining the set of alternative options, the survey instrument (generally a questionnaire), with which to acquire statements from the valuation subjects concerning their individual preferences, is organized. Although there are no pre-established and rigid schemes to refer to, it is necessary to consider the main issues to be dealt with, the priorities to be assigned to them, the time and resources needed to carry out the survey, the ways in which the selected aspects are to be posed and developed, etc.

The survey is generally applied to a representative sample of the population affected by the good (Target Population—TP); in cases where it is need to separate out the choice behaviour of different social groups, specific sub-samples may be used. Once the TP has been identified, the next steps is to choose of the sample frame population, from which the actual sample is then drawn, usually by means of randomised procedures. It is necessary for the sample to be large in order to allow a good level of statistical reliability of the data collected: a sample size of more than 500 units is required to obtain a 95% confidence interval.

After defining how to conduct the survey (by mail, by telephone, face-to-face, computer assisted, etc.), it is possible to collect the preferences of the respondents of the selected sample on the alternative options. Many types of SCMT modes exist in order to state the preferences, which differ in theoretical principle and application procedure. The most used are: Discrete Choice Experiments, Contingent Ranking, Contingent Rating, Paired Comparisons, and Binary Discrete Response (Bateman et al., 2002; Competition Commission, 2010; Hess and Daly, 2014).

It must be remembered that, before the sample population faces the full survey in which they express their preference for alternative options, one or more preliminary simulations should be carried out. In the form of pre-tests or pilot-survey, they are used to verify: if the type, number and levels of good attributes identified are appropriate; the consistency of the alternatives selected; compliance with the initial parameters taken as a reference; and the structure and functionality of the questionnaire. In practice, the pre-test must ascertain whether, in the survey, suitable conditions were observed to achieve results of formal and substantive validity.

After collecting the preferences of the selected sample of respondents, the econometric model must be defined, which allows the data on individual monetary values, obtained through the previous survey stage, to be used, for the purpose of identifying the WTP, in order to estimate the value of the good.

The model is developed around the assumption that a rational individual, given a set of alternative options, will choose the one that provides the greatest expected utility. It is further assumed that individual utility consists of a systematic component (representative utility) and a random component (random utility). One part of the utility is common to all individuals while the other is specific to the individual: the systematic component depends on the level of attributes of each alternative; the random component is the utility related to individual tastes and preferences. The random component implies the existence of important influences on the choice of an individual in the sampled population that cannot be systematically observed (Random Utility Model) (Domencich and McFadden, 1975). Randomness implies that a choice

can only be explained as the probability of that event occurring: the probability that any particular respondent prefers an option over another can be expressed as the probability that the utility associated with that option, according to the model, exceeds that associated with all other options. In specifying the model, an indirect utility function must be defined, which combines the monetary values of alternative options, the levels of the attributes of these options, and the levels of expected maximum individual utility. To complete the model, a random element must be included in the indirect utility function.

After the structure and parameters of the econometric model are defined, the distribution function of the preferences individually stated by the valuation subjects, concerning the monetary values associated with the most preferred options, can be derived. Model data can then be analyzed and it is possible to obtain the economic values intended to be estimated. The calculation of the mean and median of the distribution of these values makes it possible to estimate the individual WTP stated for the good by the population sample considered; multiplying this amount by the number of individuals in the TP leads to the aggregate WTP for the good of interest, that is, to estimate the value in the desired economic sense. A further step in the data analysis concerns the estimation of how the attributes affect the WTP (also referred to as the 'implicit price' of the attribute), which expresses the monetary value of the utility coming from a change in the level of an attribute. If the attribute is measured in the continuous, the marginal rate of substitution between the unit of an attribute and its associated monetary value represents its implicit price; if an attribute is measured in the discrete, we can express the value of a change in the level of that attribute as the WTP change needed to compensate that variation.

2.2. Characteristics of deliberative appraisal judgement of transport infrastructure

Deliberative appraisal of a particular economic aspect of the value is clearly suited to the estimate of transport infrastructure, i.e., a good capable, at the same time, both of satisfying fundamental community needs and of generating multiple and heterogeneous positive effects on citizens. Such effects can affect large and small communities, located in local, regional and national contexts.

Since it is a public good, the attribution of a value to transport infrastructure is related to the different levels of excludability and rivalry activated by it on the members of the community with which it is associated. It should be remembered that, on the one hand, a public good cannot be restricted to any of its potential consumers; on the other, no consumer can subtract any unit of the good from the consumption on the part of others (Stiglitz, 1986).

A "pure public" good, which by its nature implies the existence of effects outside the market, has no cost for the additional consumer unit. For achieving the condition of economic efficiency, it would be assumed that every consumer pays a price for it equivalent to the value assigned to it. At the opposite extreme of pure public goods there are "pure private" goods, characterized by the intrinsic presence of the factors of excludability and rivalry. In between there is a wide range of "mixed" goods that have different degree of public and private characteristics depending on how excludability

and rivalry are combined in them (Hindriks and Myles, 2006).

Because of the multiple externalities associated with public goods and the inability to be exchanged through market transactions, the market becomes unable to allocate them efficiently. This makes it impossible to estimate them on the basis of the traditional market value criterion.

In order to consider non-market effects and seek socially optimal conditions for public goods, it is necessary to take into account the various externalities in the valuation judgment. In essence, it is necessary for external effects to be quantified in monetary terms by the citizens of the affected community (Miccoli et al., 2014, 2015).

Inclusive appraisal judgements complement and integrate the other possible assignments of value. By mean of the involvement of citizens, they can provide decision-makers with essential information for the choice of policies and investments, that cannot be obtained with the other traditional appraisal methods. In this way, citizens play an active, constructive and responsible role in the definition of measures that will affect them. Inconsistent or even contrary to citizens' expectations decisions made by political representation, which risk producing socially unfair and otherwise inefficient consequences, are avoided.

Inclusive appraisals are particularly suited to: a) issues concerning infrastructure, cities, land and environment; b) goods and services that are fundamental to the community; c) issues at local level. The direct involvement of citizens on these issues leads to the qualification of such approaches as "civic appraisals" (Miccoli et al., 2023). By considering the opinions expressed directly by the members of a given community, civic and inclusive appraisals make it possible not only of procuring consensus and legitimacy for public decisions, but also of being a decisive key in conflicting and suspended decision-making situations.

The inclusive and civic connotation of appraisal judgement, from an operational point of view, can be traced back to procedural models inspired by two well-known theorizations of democracy: participatory approach and deliberative approach. With reference to these two models, participatory and deliberative appraisal judgements can be formulated. On the final decision, the judgements can have a consultative function, in the first case; binding, in the second (Cohen, 2010; Rosanvallon, 2008, 2014).

In the participatory approach, the aim is to reconnect citizens-voters with their elected representatives. An enduring exchange of information and communication between voters and elected representatives induces the two aggregates to interact and collaborate in the public decision-making process. The final decision, discussed, formed, and ratified in suitable public fora, can have greater credibility and broad social consensus (Allegretti, 2010; Fung et al., 2003; Pateman, 1970). In any case, the citizens, who never take the role and functions of the rulers, recognize the decision-making prerogatives of their elected representatives. In essence, a proper participatory process maintains a clear distinction of role and competence between the citizens and the elected political representation. Although the power of the final decision remains in the hands of the public institution, participants are called upon to contribute in a consultive form to the decision to be taken by institutional decision makers.

In deliberative democracy, the main identifying features are: 1) the inclusion in the decision-making process of all the citizens of the relevant community affected by the measure; 2) the use of informed debate to reach an unanimously shared final

decision (Bohman, 2000; Bobbio, 2002; Dryzek, 1990; Elster, 1998; Floridia and De Sanctis, 2017; Gbikpi, 2005; Mansbridge, 2015). The first point assumes that the decision-makers should not be the elected representatives or persons appointed of the public administration; instead, it will be the citizens of the community involved. Citizens—by informing, debating and collectively deciding—consciously and reasonably assert their opinion and sovereignty. By assuming this function, they are no longer identifiable as a formless multitude of individuals, but acquire a complete and homogeneous identity that no longer coincides with the summations of single individualities. The second point states the overcoming of majority voting in favor of unanimous decision. The instrument of decision-making becomes rational argumentation around the common good and the general interest, conducted by citizens consciously debating, being placed in conditions of freedom, equality and reciprocity (Habermas, 1997). This mode makes it possible to go beyond individually expressed preferences and seek a single shared preference constructed on the basis of common aims and objectives (Ackerman and Fishkin, 2008; Fishkin, 1991, 1995). The direct discussion between the participants in the debate aims at highlighting situations, perspectives and various understandings that, in its absence, would remain unknown, compromising the identification of consensual solutions. In order to achieve the concrete contribution of citizens' opinion to the subject matter, the deliberative process cannot disregard the following decisive points: a) involving all the citizens of the relevant community; b) ensuring that deliberating subjects are provided with broad and homogeneous information; c) reaching the conclusion of the judgement with a unanimous decision; sometimes, in order to overcome vetoes imposed by small minorities, deliberations approved with near-unanimity are allowed on an extraordinary basis.

In conclusion, the inclusive, civic and shared valuation of a public good by means of a deliberative procedure implies an appraisal judgement expressed by a single preference, collegially constructed by all the citizens of the community affected by the good. The judgement results in the identification of the amount of money that the demand is willing to pay for the good in question, by using a survey process based on a representative statistical sample of the community affected by the good. Statements of preference result from an in-depth, informed debate.

Therefore, because of the defining characteristics of deliberative appraisal judgement, the application of the SCMT in its standard procedure would be inadequate at least because of these main issues:

- the valuation subjects are included in the survey individually and the appraisal judgment does not express a concrete general interest, since the subject states his/her preference from a perspective aimed at optimizing his/her own position;
- the valuation subject expresses his/her preference not always completely consciously, after receiving essential but not particularly in-depth information;
- the organizing team, not the citizens, has a central role in defining the attributes, levels and alternative options, as well as the amounts to be associated with the economic attribute;
- the value of the good is obtained only by aggregation of individual preferences, using complex mathematical and statistical analysis models, which require the

help of experts in the field.

3. Results: Adaptive SCMT hypothesis

The use of the SCMT to estimate the market value of an economic good makes it possible to predict the monetary amount that is most likely to meet demand. However, the general framework of the SCMT can also be used to estimate the monetary value of a public good. Specifically, with reference to complex contingent contexts and on the basis of the preferences stated by the relevant population, the SCMT would allow the estimation of: a) the monetary value of goods that have never been produced or are subject to valorisation, using an innovative combination of attributes; b) the monetary value of the individual attributes that comprise the good, highlighting how the relative level variations affect the total value of the good; c) reliable monetary values consistent with the dynamism and changes that, in the current historical phase, tend to characterise the choices and behaviour of social contexts.

It should be noted that, due to the intrinsic nature of deliberative appraisal judgement, the application of the SCMT in its standard form would be wholly inadequate to provide a shared valuation of a public good; it is therefore necessary to adapt its standard framework in the elements that are inadequate for this purpose. The main issues of the standard procedure and the proposed indications for adapting its main elements to deliberative judgments are outlined below and summarized in **Table 1**.

Table 1. Comparison between standard procedure and deliberative procedure of SCMT.

Operational stages	Standard procedure	Deliberative procedure
Aims and scope of the survey	Defined by the organizing team	Defined by the organizing team
Sample of citizens	Composed by the organizing team	Composed by the organizing team
Qualitative study	Conducted by the organizing team	Conducted by the sample of citizens (Valuation Group) by mean of debate and shared choices
Choice sets identification	Conducted by the organizing team	Conducted by the sample of citizens (Valuation Group) by mean of debate and shared choices
Information	Essential but not detailed	Detailed and extensive
Preference elicitation	Individual preference	Shared and unanimous preference constructed by the Valuation Group
Value estimation	Aggregation of individual preferences	Shared value expressed unanimously by the Valuation Group

3.1. Role and functions assigned to the valuation subjects

A first group of issues relates to the role and functions assigned to the valuation subjects. In the standard SCMT procedure, the valuation subjects, selected from the TP (identified by the actual and potential demand of the good), are included in the survey individually, only to express their preference over the alternative options presented by the organizing team. Since the respondents state their preference in order to maximise their own situation, they behave as “consumers” and their statements reflect the interests of the valuation subject, i.e., what he/she thinks is good for him/herself.

In contrast, the SCMT used in the deliberative procedure must provide for the

valuation to be expressed directly by all citizens of the community affected by the good or, for operational needs, by a representative sample of them. In this case, after having identified the complex community context affected by the good (TP), a random sample statistically representative of the TP, which will become the Valuation Group (VG), is drawn from this. However, thanks to the development of electronic communication technology, there may be new and concrete possibilities to involve the actual community as a whole.

The SCMT must be adapted to a procedure that, being deliberative, is based on the active inclusion of citizens in a group, capable of sharing information, debating the various aspects inherent to the good being appraised, and formulating informed and generally valid preferences. The VG seeks and constructs a shared decision by taking a set of factors (deontological, ethical, social, legal, etc.) as a general reference. In carrying out this task, the valuation subjects do not ask themselves, as individuals, which choice is preferable; instead, they ask themselves, as members of community involved, which is the fair and just choice considering common beliefs, commitments and principles (Sagoff, 1998). Thus, as citizens belonging to a community, and not as mere consumers, they collectively and unanimously express their valuation on the basis of the principles that each individual believes are implicit in the character, behaviour and identity of a community seen as a whole.

3.2. Information of the valuation subjects

A second group of issues requiring adjustment concerns the knowledge base of the valuation subjects on the subject matter to be dealt with. Participants in the standard SCMT state their preferences after receiving essential but not particularly targeted and detailed information. Therefore, their preferences are not always expressed in full awareness and sometimes the lack of clarity can result in cognitive biases.

The deliberative procedure, on the other hand, requires the VG to have a thorough and extensive information base. The information to be acquired by the VG must provide it with broad perspectives to fully understand the current context and produce specific knowledge capable of making the judgments legitimated. Therefore, during the first session of meetings, the VG must be provided with: 1) a homogeneous basic information framework, through a detailed description of the good to be valued and an illustration of the valuation scenario; 2) a presentation of the valuation technique, indicating the purposes of the study, the criterion and the procedure used. On the basis of the preliminary information received, the VG is invited to indicate, in an agreed manner, a list of categories of experts and stakeholders from which to select the subjects to be consulted in order to deepen their knowledge of the good to be valued. Subsequently, the identified figures are convened for the meetings of the consultation phase. During the meetings the experts and stakeholders will be at the disposal of the VG to clear up any doubts and to obtain different positions and points of view from the various actors involved. Only if the level of information is considered exhaustive by the VG, it is possible to proceed to the formulation of the appraisal judgments; if not, the consultations can be repeated with the addition of new experts and new stakeholders, if deemed necessary (**Figure 2**).

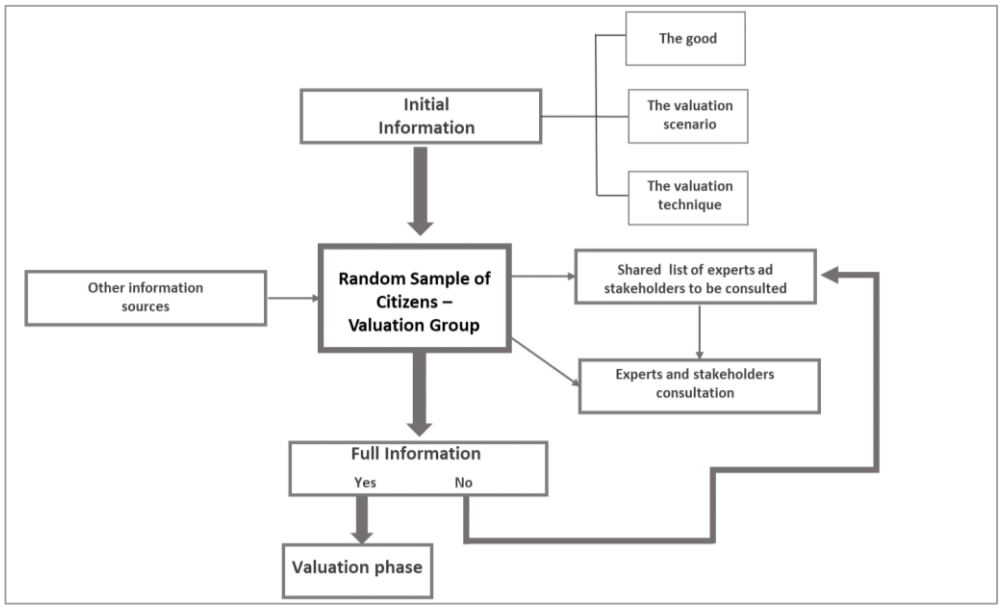

Figure 2. Structure of information phase of the adaptive stated choice modelling technique with deliberative procedure.

3.3. Operational procedure

A third group of issues involves the design of the alternative options of the good to be valued, the elicitation of monetary value, and the choice of the most preferred option. Reference is made to the procedures that must be followed in order to comply with the aforementioned requirements, which are entirely different in the standard and deliberative SCMT. In the latter procedure, the debate phase carried out by the members of the VG has an essential role and a decisive function.

When applying the standard procedure, during the qualitative study, the organizing team establishes the main elements (attributes and their levels) on the basis of which the different options are drawn. Subsequently, through the experimental design, the organizing team, combining attributes and relative levels, outlines the different alternative options to be valued by the respondents. The organizing team thus has a central role in defining the attributes, levels and alternative options, as well as the amounts to be associated with the economic attribute, i.e., the monetary value. Having established the set of alternative options, after organizing the survey instrument and defining how to conduct the survey, it is possible to collect the preferences stated by the selected valuation subjects, using one of the many existing modes (see section 2.1.). The elicitation of preferences, of an individual type, thus exclusively captures the individual interest. Finally, after collecting the preferences, the econometric model is defined, which allows the data to be used to estimate the value of the good; the model allows the estimation of the mean or median individual WTP (stated by the subjects involved in the survey); the product between this amount and the number of individuals of the TP leads to the calculation of the aggregate WTP for the alternative options of the good to be valued. Since the estimation is done through the aggregation of individual preferences, this is done on the basis of an abstract mean or median ranking.

In the deliberative procedure (**Figure 3**), informed discussion, held by the

members of the VG, constitutes a mandatory component. With the intention of refining the choice process through progressive operational levels, this activity requires some fundamental tasks that the VG is called upon to perform. In a preliminary phase it performs tasks that concern: a) the constitution of the aggregate of attributes of the good, indicating for each of them the degree of priority and the interval of variation of the level (including the economic attribute); b) the composition of the set of possible alternative options (choice sets), if necessary, with the aid of specific computer software. Regarding the attribution of monetary value to the good, the VG, in its collegiality and in sharing, constructs and formulates, for each alternative configuration, an individual WTP referred to the formal citizen of the community involved (i.e., a citizen with average or ordinary social and economic characteristics). After initial orientation statements on the elements to be shared, the members of the VG begin to discuss by proposing arguments, providing justifications to support their opinions; the alternation of discussions and statements is repeated until a decision shared by all the subjects of the VG is reached.

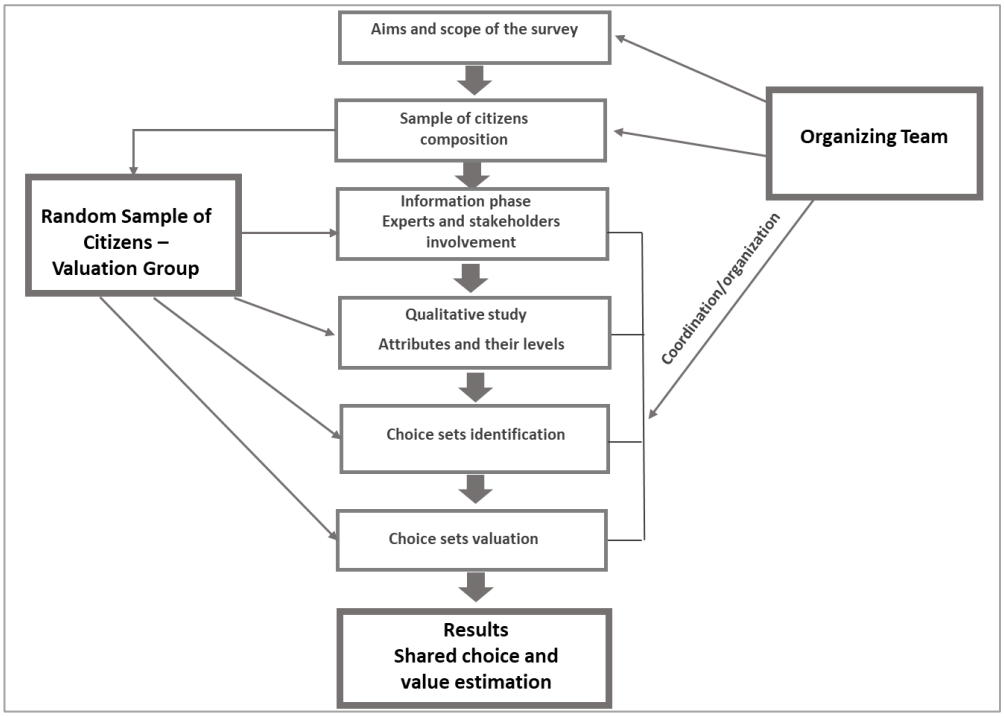

Figure 3. Operational stages of the adaptive stated choice modelling technique with deliberative procedure.

The VG then proceeds, in general sharing, to choose the preferred modelling. The group starts the procedure of choosing the shared configuration after trying to construct proposals of broad convergence and after eliminating those that are clearly dominated by others. This results in a limited number of alternatives that are more easily and effectively managed in the selection process. In the absence of a unanimous shared choice, the group tries to reach general agreement by mean of reasonable adjustments in the modeling of greater preferability.

The alternatives under consideration are posed for discussion: first individually, analyzing their connotations and identifying their strengths and weaknesses; then,

comparing them with each other. After the initial statements of orientation on the preferred alternative, the VG members discuss, offering arguments, providing justifications to support their opinions, reiterating the alternating discussions and statements, until a choice shared by all VG is reached.

The collegial and unanimous indication of preferences may take place by means of the different modes indicated above (see section 2.1.), properly adapted to deliberative procedure. The mode is chosen according to the purpose and objectives of the survey: when the aim is to select only the most preferred option, the Discrete Choice Experiments can be used; in order to obtain a complete ranking of the alternative options, Contingent Ranking or the Contingent Rating can be employed.

The WTP assigned to the selected option, extended to the TP, makes it possible to determine the total WTP of that alternative option, i.e., to estimate its value in the desired economic sense.

4. Discussion

In order to empirically validate the SCMT adapted to a deliberative appraisal procedure, a specific experimental program must be designed and implemented, to be developed both in the laboratory and in the field. In addition, it will be necessary to subject the results of the experiments to an appropriate technical-scientific check with the involvement of representatives of governmental, central and local institutions.

Although field experiments produce results that can be considered of greater significance and are in any case necessary, at an early stage it would be inappropriate to conduct the experimental validation procedure in a real context. Such an operation, given the complexity of the elements involved, may be more practicable and profitable if carried out in a controlled experimental environment. In this context, on the basis of the results progressively obtained, new solutions can be easily tried out and inadequacies and errors emerged in repeated experiments can be corrected.

An experimental laboratory (Eber and Willinger, 2005) conducted at an early stage with a real sample of citizens would take a long time. It would be necessary to find citizens capable of accurately representing the characteristics of the community under examination and willing to participate in the various experimental sessions. In order to incentivise their active participation, it might be necessary to provide them with monetary compensation. Ultimately, this option, without securing on the suitability of the expected results, would be considerably burdensome in both financial and time terms.

In the first instance, therefore, it would be preferable to set up an experimental laboratory utilising the role-playing games (Satu, 2004; Steinkuehler et al., 2011; Tychsen, 2006; Tychsen et al., 2006), conducted with individuals willing to participate voluntarily and free of charge.

4.1. Target population and sample

Once the subject matter on which to focus the experimentation has been defined, participants in the game would have to interpret the behavior of a sample of citizens representative of the community affected by the good to be valued (TP).

Given the nature and complexity of the goods to be valued (public goods), the TP

associated with them is often not easily identifiable. In order to accurately define the size and characteristics of the adult population of the community involved (in terms of age, gender, profession, level of education, etc.), it can be necessary to proceed to the identification of the TP on the basis of a preliminary socio-demographic survey. It is also recommended to acquire information on the community's behavior, attitudes and expectations regarding the good through specific pilot interviews conducted on a sample of citizens, also using the Focus Group technique.

In order to determine the size of the representative sample from the TP, i.e., the VG, is recommended to refer to the sizes commonly used in experiments conducted in past applying deliberative procedures (Álvarez-Farizo et al., 2007; Gregory and Wellman, 2001; James and Blamey, 2005; Lienhoop and MacMillan, 2007; Macmillan et al., 2002; Urama and Hodge, 2006; Ward, 1999). In this context, some are based on small samples (consisting of fewer than 25–30 individuals), others involve larger samples (up to several hundred people). Large samples ensure a good representativeness of TP but also require more equipment and human and financial resources than small samples. The preference for the latter is supported by the finding that, in general, the quality of communication is negatively affected by the size of the valuation group: the larger it is, the more difficult it is to reach a deliberation; furthermore, the smaller sample size would make it easier to develop the dynamics leading to the identification of a set of values to be shared and a common identity to be protected; to this end, even in experiments conducted with large samples, participants in the debate are often arranged in subgroups or small discussion tables.

The preliminary investigations also make it possible to define the fundamental characters of each component of the sample that the participants in the game will have to interpret. Subsequently, it is possible to proceed with the assignment of roles to the participants, after introducing the context of the case study and illustrating the main features of the characters. Since the participants are usually people who are not experts in the art of role-playing, in order to have a realistic and faithful representation of the characters making up the sample, it is preferable to assign the roles on the basis of the tendencies expressed by the participants and, then, to start a phase of identification with the character, before starting the actual experimentation. This phase appears crucial in helping each of the subjects involved in the experiment to adhere more closely to the role assigned to him or her. In this sense, it is considered appropriate to organize a series of meetings, during which each subject interprets his or her character in the presence of the other members of the VG. During the meetings, the subjects can correct and improve the interpretation on the basis of the suggestions received from the other participants.

4.2. Contingent scenario

Before proceeding with the experiment, it is necessary to define the elements characterizing the "contingent scenario" typical of a deliberative procedure, i.e., the hypothetical context to which reference must be made in order to express the appraisal judgement. The scenario describes a possible future state on the basis of a dynamic forecast of events, conditions and changes that may occur; therefore, it always stems from an autonomous design of the future possibilities of the context considered; in any

case, it is never necessarily inferred by the present situation, although it may intentionally confirm its maintenance or continuity.

When estimating a public good, the definition of the "contingent scenario" is an operation that is considerably complex, given the multiplicity of factors that can affect its connotation and vary its structure (e.g., the good to be valued, the collective valuation subject, and the multitude and heterogeneity of citizens that identify the community affected by the good). For its identification, therefore, it may be necessary to employ special methodologies (such as Scenario Analysis, Scenario Planning, etc.). Such qualitative and quantitative methods of analysis and forecasting consist of identifying a series of possible alternatives for a group of variables, "allowing different ideas and intuitions to be combined to design the future and analyse the impact of possible events and decisions" (Schoemaker, 1995). In laboratory experiments, it is recommended to identify several alternative contingent scenarios, varying the reference conditions and holding certain fundamental elements constant, in order to detect the sensitivity of the outcomes of the experiments to these changes.

4.3. Information

In the deliberative procedure, the preparation of an in-depth and extensive information base is a crucial condition for achieving results consistent with the deliberative principles. All VG components must become fully aware of the appraisal judgment they are called upon to express within the group. Therefore, within the framework of the experimentation, particular attention should be paid: a) to gathering impartial and balanced information, on the basis of which the members of the VG can express their judgements; b) to providing them with a framework of essential economic and appraisal knowledge on the specific issue, (also with theoretical and methodological assistance from valuation experts).

In addition, data derived from Internet resources, concerning the issue investigated, can also be presented to the VG to broaden the horizons of its knowledge and its own information base.

4.4. Debate and shared valuation

During the different sessions of the deliberative procedure, the VG must arrive at the construction of a shared and unanimous choice through an articulate, regulated and responsible debate. At the opening of the sessions, therefore, it would be appropriate to bring to the attention of the VG: a) the meaning and purpose of the appraisal that it is about to undertake; b) the complex scenario hypothesised and placed under appraisal, highlighting the key elements; c) the main indications that have emerged on the basis of the initial information provided and the knowledge acquired through the hearings of experts and stakeholders. In order to reach a shared choice, it is good to remind the members of the VG that, in formulating their opinion, they must go beyond their personal vision, placing themselves in the perspective of the common good and with regard to the positions of the other members of the group; moreover, they must take into account the heterogeneous set of impacts that the good may generate. The debating process of a deliberative procedure must allow a system of common values to emerge as orientation in the construction of the appraisal judgement; in the course

of experimentation, the debate may be repeated several times and even require lengthy sessions.

With regard to the unanimity criterion, it must be pointed out that, in the context of experiments, there may be probable vetoes placed by minorities—even very small in numerical terms but relevant from the point of view of their ability to influence the community—which could lead to a shared decision not being reached. In some experiments conducted under real-life conditions, deliberations approved with near-unanimity are sub-optimally allowed; but, in laboratory experiments, the recourse to majority forms would end up by invalidating the most authentic sense of a deliberative process. In such cases, it is preferable to highlight the elements that did not allow unanimity to be reached and to reiterate the experiment, making the changes and adjustments necessary to enable general agreement to be reached.

5. Conclusion

The SCMT is evidently efficient and useful in identifying the combination of attributes of a market good that is most appreciated by relative demand. The monetary value assigned by the possible consumerswill be the one most likely to become the price in an actual market exchange. Essentially, SCMT allows for appraisal judgements that are consistent with the dynamism and uncertainties that currently characterise markets. However, the breakthrough produced by the introduction of psychological criteria into the SCMT led to considering the utility provided by the good as a function of the attributes subjectively recognised by consumers.

When the appraisal concerns the particular economic aspect of the value—estimated in a shared form by a community—to be assigned to transport infrastructure, it is necessary to resort to judgements that are inclusive of all the citizens of the community affected by the good and are unanimously shared.

Given the intrinsic characteristics of deliberative appraisal judgments, the unsuitability of the standard SCMT appears evident, since its theoretical-methodological configuration envisages that the valuation subjects are: a) involved individually, b) behave as consumers, and c) inform their choice statements to self-interest; moreover, the monetary value estimation is obtained through the aggregation of individual preferences.

Hence the necessity to make specific adjustments to the standard SCMT: a) the collegial involvement of the valuation subjects; b) the awareness and responsibility acquired through appropriate information and debating; c) the search for a shared and unanimous final decision. All these elements constitute essential and mandatory adaptations to arrange a SCMT fully usable in deliberative appraisal judgements.

The empirical validation of the proposed adaptive SCMT cannot disregard the preparation and implementation of a detailed programme of experiments to be conducted in the laboratory and in the field, defined on the basis of the indications outlined herein. The resources to be committed are considerable, but the achievable benefits, in terms of social consensus to the public decisions to be taken, advise against disregarding this task.

Author contributions: Conceptualization, SM and RM; writing—review and editing,

SM and RM. reviewed the results, SM and RM; approved the final version, SM and RM. All authors have read and agreed to the published version of the manuscript.

Conflict of interest: The authors declare no conflict of interest.

References

Abelson, R. P. (1986). Beliefs Are Like Possessions. Journal for the Theory of Social Behaviour, 16(3), 223–250. https://doi.org/10.1111/j.1468-5914.1986.tb00078.x

Ackerman, B., Fishkin, J. S., (2008). Deliberation Day. Yale University Press, New Haven.

Adamowicz, V., Boxall, P. (2001). Future directions of stated choice methods for environment valuation. Available online: https://www.researchgate.net/publication/266161818 (accessed on 3 May 2023).

Allegretti, U. (2010). Participatory Democracy (Italian). Firenze University Press. https://doi.org/10.36253/978-88-8453-548-1

Álvarez-Farizo, B., Hanley, N., Barberán, R., et al. (2007). Choice modeling at the "market stall": Individual versus collective interest in environmental valuation. Ecological Economics, 60(4), 743–751. https://doi.org/10.1016/j.ecolecon.2006.01.009

Bateman, I. J., Carson, R. T., Day, B., et al. (2002). Economic Valuation with Stated Preference Techniques. Elgaronline.

Bobbio, L. (2002). Deliberative arenas (Italian). Rivista Italiana di Politiche Pubbliche. p. 3.

Bohman, J. (2000). Public deliberation: pluralism, complexity, and democracy. MIT Press.

Bradley, R. A., & El-Helbawy, A. T. (1976). Treatment contrasts in paired comparisons: Basic procedures with application to factorials. Biometrika, 63(2), 255–262. https://doi.org/10.1093/biomet/63.2.255

Burgess, L., & Street, D. J. (2003). Optimal Designs for 2kChoice Experiments. Communications in Statistics - Theory and Methods, 32(11), 2185–2206. https://doi.org/10.1081/sta-120024475

Cohen, J. (2010). Rousseau: A Free Community of Equals. Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199581498.003.0002

Competition Commission. (2010). Review of stated preference and willingness to pay methods. White Paper.

Domencich, T. A., McFadden, D. (1975). Urban Travel Demand: A Behavioral Analysis. North-Holland Publishing Company Limited.

Dryzek, J. S. (1990). Discursive Democracy. Cambridge University Press. https://doi.org/10.1017/9781139173810

Eber, N., & Willinger, M. (2005). Experimental economics (French). Repères. https://doi.org/10.3917/dec.eber.2005.01

Elster, J. (editor). (1998). Deliberative Democracy. Cambridge University Press. https://doi.org/10.1017/cbo9781139175005

Fishkin, J. S. (1991). Democracy and deliberation: new directions for democratic reform. Yale University Press.

Fishkin, J. S. (1995). The voice of the people: public opinion and democracy. Yale University Press.

Floridia, A., De Sanctis, S. (2017). From participation to deliberation: a critical genealogy of deliberative democracy. Colchester: ECPR Press.

Fung, A., Wright, E. O., Abers, R. (2003). Deepening democracy: institutional innovations in empowered participatory governance. Verso.

Gbikpi, B. (2005). From the theory of participatory democracy to deliberative democracy: what possible continuities (Italian)? Società editrice Il Mulino S.p.A., 1, 97–130. https://doi.org/10.1425/19636

Gregory, R., Wellman, K. (2001). Bringing stakeholder values into environmental policy choices: a community-based estuary case study. Ecological Economics, 39(1). https://doi.org/10.1016/S0921-8009(01)00214-2

Habermas, J. (1996). Between Facts and Norms. Polity. https://doi.org/10.7551/mitpress/1564.001.0001

Hancock, T. O., Broekaert, J., Hess, S., et al. (2020). Quantum choice models: A flexible new approach for understanding moral decision-making. Journal of Choice Modelling, 37, 100235. https://doi.org/10.1016/j.jocm.2020.100235

Heller, P., & Rao, V. (2015). Deliberation and Development: Rethinking the Role of Voice and Collective Action in Unequal Societies. The World Bank. https://doi.org/10.1596/978-1-4648-0501-1

Hernandez, J. I., van Cranenburgh, S., Chorus, C., et al. (2023). Data-driven assisted model specification for complex choice experiments data: Association rules learning and random forests for Participatory Value Evaluation experiments. Journal of Choice Modelling, 46, 100397. https://doi.org/10.1016/j.jocm.2022.100397

Hess, S., & Daly, A. (editor). (2014). Handbook of Choice Modelling. Edward Elgar Publishing. https://doi.org/10.4337/9781781003152

Hindriks J., Myles G. D. (2006). Intermediate public economics. The MIT Press.

Hu, M., & Shealy, T. (2023). Priming the public to construct preferences for sustainable design: A discrete choice model for green infrastructure. Journal of Environmental Psychology, 88, 102005. https://doi.org/10.1016/j.jenvp.2023.102005

James R. F., Blamey R. K. (2005). Deliberation and economic valuation: national park management. In: Getzner, M., Spash, C. L., & Stagl, S. (editors). Alternatives for Environmental Valuation. Routledge.

Jiang, N., Ao, C., Xu, L., et al. (2023). Will information interventions affect public preferences and willingness to pay for air quality improvement? An empirical study based on deliberative choice experiment. Science of The Total Environment, 868, 161436. https://doi.org/10.1016/j.scitotenv.2023.161436

Kahneman, D., Knetsch, J. L., & Thaler, R. H. (1990). Experimental Tests of the Endowment Effect and the Coase Theorem. Journal of Political Economy, 98(6), 1325–1348. https://doi.org/10.1086/261737

Kassahun, H. T., Swait, J., & Jacobsen, J. B. (2021). Distortions in willingness-to-pay for public goods induced by endemic distrust in institutions. Journal of Choice Modelling, 39, 100271. https://doi.org/10.1016/j.jocm.2021.100271

Lancaster, K. (1971). Consumer demand: a new approach. Columbia University Press.

Lancaster, K. J. (1966). A New Approach to Consumer Theory. Journal of Political Economy, 74(2), 132–157. https://doi.org/10.1086/259131

Lienhoop, N., & MacMillan, D. (2007). Valuing wilderness in Iceland: Estimation of WTA and WTP using the market stall approach to contingent valuation. Land Use Policy, 24(1), 289–295. https://doi.org/10.1016/j.landusepol.2005.07.001

Louviere, J. J., Hensher, D. A., Swait, J. D., et al. (2000). Stated Choice Methods. Cambridge University Press. https://doi.org/10.1017/cbo9780511753831

Luce, R. D. (1959). Individual choice behavior: a theoretical analysis. Wiley.

Lusk, J. L., & Norwood, F. B. (2005). Effect of Experimental Design on Choice-Based Conjoint Valuation Estimates. American Journal of Agricultural Economics, 87(3), 771–785. https://doi.org/10.1111/j.1467-8276.2005.00761.x

Macmillan, D. C., Philip, L., Hanley N., Alvarez, F. B. (2002). Valuing the nonmarket benefits of wild goose conservation: A comparison of interview and group-based approaches. Ecological Economics, 43. https://doi.org/10.1016/S0921-8009(02)00182-9

McFadden, D. (2014). The new science of pleasure: consumer choice behavior and the measurement of well-being. In: Handbook of Choice Modelling. Edward Elgar Publishing. https://doi.org/10.4337/9781781003152.00007

Miccoli, S., Finucci, F., & Murro, R. (2014). A Monetary Measure of Inclusive Goods: The Concept of Deliberative Appraisal in the Context of Urban Agriculture. Sustainability, 6(12), 9007–9026. https://doi.org/10.3390/su6129007

Miccoli, S., Finucci, F., & Murro, R. (2015). Measuring Shared Social Appreciation of Community Goods: An Experiment for the East Elevated Expressway of Rome. Sustainability, 7(11), 15194–15218. https://doi.org/10.3390/su71115194

Miccoli, S., Finucci, F., Murro, R. (2023). Deliberative Estimated Value—Civic Estimate Experiments (Italian). Available online: https://www.ubiklibri.it/book-9788835137115-valore-di-stima-deliberativo-sperimentazioni-di-estimo-civico.html (accessed on 3 May 2023).

Pateman, C. (1970). Participation and Democratic Theory. Cambridge University Press. https://doi.org/10.1017/cbo9780511720444

Pearce D., Ozdemiroglu E. Day, B., et al. (2002). Economic Valuation with Stated Preference Techniques—Summary Guide. Edword Elgar Publishing.

Peterson, G. D., Cumming, G. S., & Carpenter, S. R. (2003). Scenario Planning: a Tool for Conservation in an Uncertain World. Conservation Biology, 17(2), 358–366. https://doi.org/10.1046/j.1523-1739.2003.01491.x

Rosanvallon, P. (2008). Democratic legitimacy. Impartiality, Reflexivity, Proximity (French). Editions du Seuil, Paris.

Rosanvallon, P. (2014). Counter-democracy - politics in the age of mistrust (French). Éditions du Seuil, Paris.

Rosen, S. (1974). Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition. Journal of Political Economy, 82(1), 34–55. https://doi.org/10.1086/260169

Saarikoski, H., Aapala, K., Artell, J., et al. (2022). Multimethod valuation of peatland ecosystem services: Combining choice experiment, multicriteria decision analysis and deliberative valuation. Ecosystem Services, 57, 101471. https://doi.org/10.1016/j.ecoser.2022.101471

Sagoff, M. (1998). Aggregation and deliberation in valuing environmental public goods: A look beyond contingent pricing. Ecological Economics 24(2). https://doi.org/10.1016/S0921-8009(97)00144-4

Sándor, Z., & Wedel, M. (2002). Profile Construction in Experimental Choice Designs for Mixed Logit Models. Marketing Science, 21(4), 455–475. https://doi.org/10.1287/mksc.21.4.455.131

Satu, H. (2004). Role-Playing: A Narrative Experience and a Mindset. In: Markus, M. E., & Stenros, J. (editors). Beyond Role and Play: Tools, Toys and Theory for Harnessing the Imagination. Ropecon ry, Helsinki

Schoon, R., & Chi, C. (2022). Integrating Citizens Juries and Discrete Choice Experiments: Methodological issues in the measurement of public values in healthcare priority setting. Social Science & Medicine, 309, 115223. https://doi.org/10.1016/j.socscimed.2022.115223

Steinkuehler, C., Squire, K., & Barab, S. (2012). Games, Learning, and Society. Cambridge University Press. https://doi.org/10.1017/cbo9781139031127

Stiglitz, J. E. (1986). Economics of the Public Sector, Second Edition. Norton & Co.

Thurstone, L. L. (1994). A law of comparative judgment. Psychological Review, 101(2), 266–270. https://doi.org/10.1037/0033-295x.101.2.266

Tychsen, A. (2006). Role Playing Games—Comparative Analysis Across Two Media Platforms. In: Proceedings of the Proceedings of the 3rd Australasian conference on Interactive entertainment; Australia.

Tychsen, A., Hitchens, M., Brolund, T., et al. (2006). Live Action Role-Playing Games. Games and Culture, 1(3), 252–275. https://doi.org/10.1177/1555412006290445

Urama, K. C., & Hodge, I. (2006). Participatory Environmental Education and Willingness to Pay for River Basin Management: Empirical Evidence from Nigeria. Land Economics, 82(4), 542–561. https://doi.org/10.3368/le.82.4.542

van Cranenburgh, S., Wang, S., Vij, A., et al. (2022). Choice modelling in the age of machine learning - Discussion paper. Journal of Choice Modelling, 42, 100340. https://doi.org/10.1016/j.jocm.2021.100340

Ward, H. (1999). Citizens' juries and valuing the environment: A proposal. Environmental Politics, 8(2), 75–96. https://doi.org/10.1080/09644019908414462