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SOCRATES Manual

Software Manual for Social Multi-Criteria Evaluation, Version November 2022

Munda G., Azzini I., Cerreta M. and Ostlaender N.

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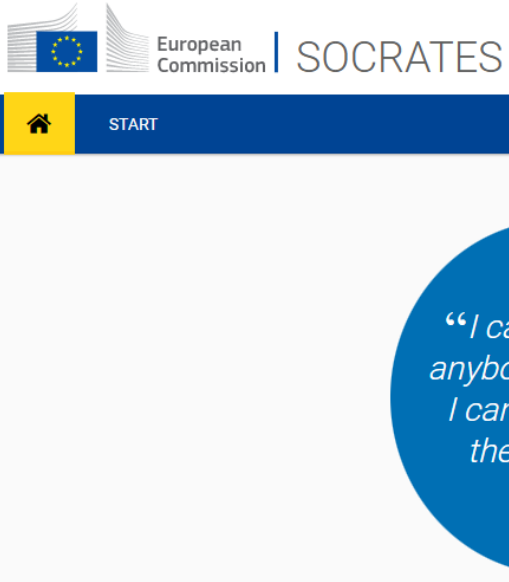

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Contact information
Name: Giuseppe MUNDA
Address: European Commission, Joint Research Centre – Via E .Fermi 2749 – I-21027 – Ispra (Va) - ITALY
Email: giuseppe.munda@ec.europa.eu

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Contents

Abstract

SOCRATES (**SO**cial multi-**CR**iteria **A**ssessmen**T** of **E**uropean policie**S**) is a software tool explicitly designed for impact assessment problems. Three main components constitute the core of SOCRATES: multi-criteria, equity and sensitivity analyses. The impact matrix may include quantitative (including also stochastic and/or fuzzy uncertainty) and qualitative (ordinal and/or linguistic) measurements of the performance of an alternative with respect to an evaluation criterion. It supplies a ranking of the alternatives according to the set of evaluation criteria by using a non-compensatory mathematical aggregation rule. Equity analysis requires as input a set of social actors and the impact of the alternatives on these social actors. The objective of sensitivity analysis is to check if the ranking provided is stable and to determine which of the input parameters influence more the model output. The entire information produced by local and global sensitivity analyses is synthesised into simple graphics.

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Authors

Giuseppe Munda, Ivano Azzini, Maria Cerreta and Nicole Ostlaender

1 Introduction - Why SOCRATES?

SOCRATES (**SO**cial multi **CR**iteria **A**ssessmen**T** of **E**uropean policie**S**) is a multiple criteria software tool explicitly designed for *ex-ante* Impact Assessment (IA) problems. Since IA is multidimensional in nature, Multi-Criteria Decision Analysis (MCDA) and in particular Social Multi-Criteria Evaluation (SMCE), which has been explicitly designed for public policy, can be a very useful methodological and operational framework. A Social Multi-Criteria Evaluation framework is useful for integrating a plurality of technical aspects and social views into an ex-ante impact assessment in a coherent and transparent manner.

SMCE allows taking into account a wide range of assessment criteria; for example, the impact on Small and medium-sized enterprises (SMEs), the degree of protection of fundamental rights, consumer protection, etc. All the multidimensional profiles of the problem are shown in their original scales of measurement; the *impact matrix* presents in a structured way the information on the various criterion scores, i.e. each element of the matrix represents the performance of each option according to each evaluation criterion.

The implementation of a Social Multi-Criteria framework involves the following main steps:

1. Selection of the social actors relevant for the problem at hand.
2. Definition of social actors' values, desires and preferences.
3. Generation of evaluation criteria as a process of technical translation of social actors' needs, preferences and desires.
4. Construction of the multi-criteria impact matrix.
5. Construction of an equity impact matrix, illuminating all the distributional consequences of each single option in terms of stakeholder types.
6. Application of a mathematical procedure.
7. Sensitivity and robustness analysis.

The application of SMCE is not particularly time consuming, since it formalises in a consistent and efficient way a process that often is already done in the current practice of IA (almost all IA studies present the results in the form of an impact matrix). Moreover, the support of a software tool makes all required computations very quick.

The objective of SOCRATES is NOT substitution of policy-makers through a mathematical model, on the contrary, the objective is to improve their understanding of the main features of the problem at hand, such as key assumptions, degree of uncertainty, robustness of results and overall technical and social defensibility of options chosen. The philosopher Socrates said "*I cannot teach anybody anything. I can only make them think.*"This is the main inspiring principle of the SOCRATES software too.

In summary, why SMCE and why SOCRATES in IA studies?

— SMCE is a well-established methodology for IAs. It provides structured steps to build the impact matrix and rank all the feasible policy options.

— By using SOCRATES, it is possible to add consistency between the problem structuring and the selection of a desirable option, thus improving transparency too.

— By using SOCRATES, it is possible to assure repeatability of the calculation; which adds to the overall goal of transparency.

2 What is SOCRATES?

Social Multi-Criteria Evaluation proceeds on the basis of the following main concepts: dimensions, objectives, criteria, weights, criterion scores, impact matrix and compromise solution.

Dimension is the highest hierarchical level of analysis and indicates the scope of objectives, criteria and criterion scores. In IA studies, the general categories of economic, social and environmental impacts are dimensions.

Objectives indicate the direction of change desired, e.g. growth has to be maximized, social exclusion has to be minimized, carbon dioxide emissions have to be reduced.

A **Criterion** is a function that associates alternative actions with a variable indicating its desirability.

Weights are often used to represent the relative importance attached to dimensions, objectives and criteria. The idea behind this practice is very intuitive and easy, that is, to place the greatest number in the position corresponding to the most important factor.

A **Criterion score** is an assessment of the impact consistent with a given criterion with reference to a policy option. Criterion scores can be qualitative and/or quantitative.

The **Impact Matrix** presents, in a structured way, the information on the various criterion scores, i.e. each element of the matrix represents the performance of each option according to each criterion. In general, in a multi-criterion problem, there is no solution (ideal or utopian solution) optimising all the criteria at the same time, and therefore "**compromise solutions**" have to be found.

Three main components constitute the core of SOCRATES: multi-criteria, equity and sensitivity analyses. **Multi-Criteria analysis** requires the definition of relevant dimensions, objectives and criteria. It uses weights as importance coefficients and clarify their role in the hierarchical structure. The impact matrix may include quantitative (including also stochastic and/or fuzzy uncertainty) and qualitative (ordinal and/or linguistic) measurements of the performance of an alternative with respect to an evaluation criterion. It supplies a ranking of the alternatives according to the set of evaluation criteria (i.e. the technical compromise solution/s).

Equity analysis requires as input a set of social actors and the impact of the alternatives considered in the multi-criteria analysis on these social actors. The equity analysis produces the following information:

- indications of the distance of the positions of the various social actors (i.e. possibilities of convergence of interests or coalition formations);
- ranking of the alternatives according to actors' impacts or preferences (social compromise solution).

The objective of **sensitivity analysis** is to check if the rankings provided are stable and to determine which of the input parameters influence more the model output. The whole information produced by local and global sensitivity analyses is synthesised into simple graphics.

SMCE is a methodology widely used in many geographical contexts around the world. Many peer reviewed publications on SMCE exist both on the methodological and empirical aspects. SOCRATES is based on research developed at JRC, fully published in top international scientific journals. All methodological and mathematical details of SOCRATES can be found in the list of publications at the end of this manual (Azzini and Munda, 2020; Munda, 2004; Munda, 2008; Munda and Nardo, 2009; Munda, 2012; Munda, 2022; Saltelli *et al.,* 2010).

In summary, SOCRATES presents the following main characteristics:

- it can deal with mixed information in a mathematically correct way (thanks to an appropriate semantic distance);
- appropriate mathematical rules guarantee that weights have always the meaning of importance coefficients;
- it can deal with both a technical impact matrix and a social impact matrix;

— it is based on the Kemeny median rule, which is considered one of the best possible non-compensatory aggregation rules from both social choice and multi-criteria literature;

— the computational problem linked to the use of the median rule has been tackled by a new numerical algorithm currently considered the benchmark in the specialized scientific literature;

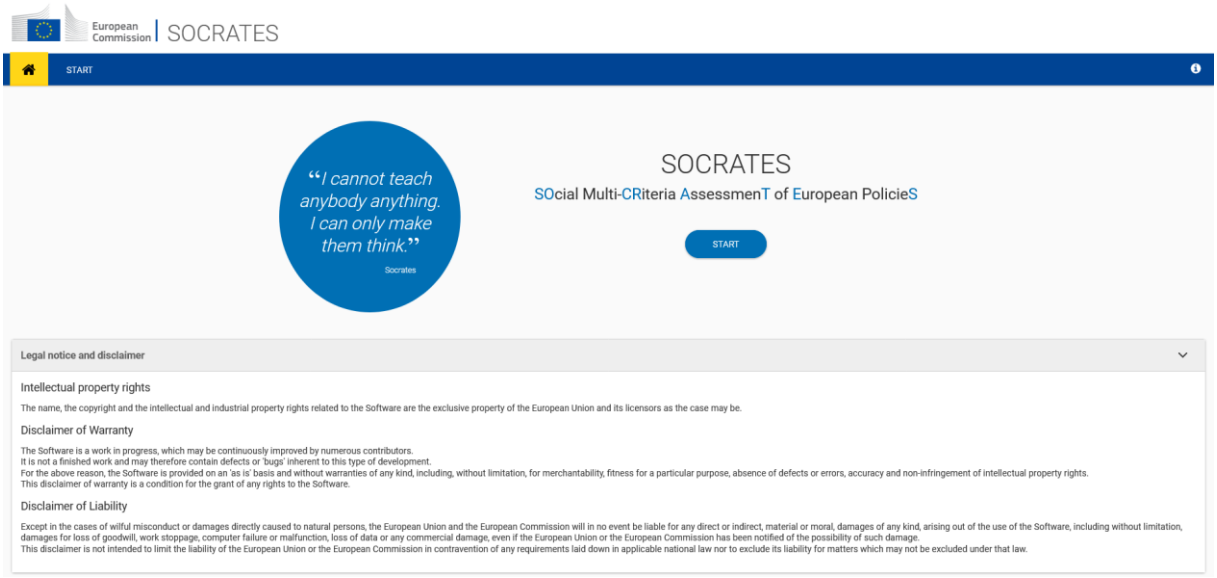
— the robustness of results is tested by using both local and global sensitivity analyses.

Box 1: Copyright warning, legal notices and disclaimer

3 How to start and manage a project

The SOCRATES software is an on line application.

It can be found under https://web.jrc.ec.europa.eu/socrates/ ; when clicking on this link, you can see the following Graphical User Interface (GUI):



The blue bar at the top of the GUI contains the following buttons:

Home

It takes you to the home screen

Start

Click on one of them to start a new project (only if you have not already opened one).

Info

It provides you with information **About** SOCRATES and a **Contact**

After clicking on Start, in the upper right corner of the GUI, the blue bar at the top of the GUI contains the following buttons:

Home

It takes you to the home screen

Start

It allows you starting a new project (only if you have not already opened one).

Info

It provides you with information **About** SOCRATES and a **Contact**

In the upper right corner of the GUI, the bar shows the possibilities to save, edit, or load a datafile.

The button **Manage** opens a drop-down menu to work with the project file, where you can:

New project

Create a new project from scratch

Import / Restore

Load an existing project or restore a backup

Duplicate

Create a copy of your project

Rename

Change the name of your project

Export

Export your project in json format

Backup projects

Download a backup for all your projects in json format

Delete

Delete all data in your project

The button **Save** opens a drop-down menu to:

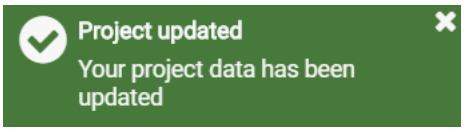
Save on this browser

The project is saved in your browser IndexedDB

Save and export

The project is saved in your browser IndexedDB and you must Download export file from the link that appears under the **Save** button

For saving the datafile, it can be selected a local or remote saving procedure. If the saving was successful, a push-up notification comes up in the lower right-hand corner.



You can also select the **AUTOSAVE** option activating the button under the Save button on the right corner of the GUI.

The project will be saved in the browser IndexedDB, and will remain available as long as you don't change PC and browser or don't clear the cache. For maximum security, we suggest exporting your work when you leave.

4 SOCRATES workflow

This chapter explains the operations of the software by guiding you through the **tasks** and **steps** of the process. Typical components of a multi-criteria decision process are implemented.

The following example helps you to understand which information SOCRATES needs to support your decisions.

The Condominium problem

What is the best-suited alternative to design a condominium's common area?

Twelve families and six professional studios occupy a six-floor condominium with 18 apartments (three per floor) and two shops on the ground floor. The co-owners must decide a preferable alternative among five to renovate approximately 500 square meters of external common spaces. The occupants of each condo unit have different opinions about the best-suited transformation. After a first meeting, six primary groups of interest have emerged:

- Merchants (living on the ground floor);
- Professional consultants (living on the first and second floors);
- Residents of the 3° floor;
- Residents of the 4° floor;
- Residents of the 5° floor;
- Residents of the 6° floor.

The occupants proposed five alternatives to change the building's external spaces:

Garden

Baby Playground

Parking Areas

Paved Areas

Vegetable Garden and Orchard

A set of eight objectives linked to three dimensions (Economy, Society, Environment) was established to support the final decision. Each objective relates to one or more criteria representing the function that associates alternatives with a qualitative or quantitative variable, indicating its desirability (Please see section 4.1 for more information).

The user can implement the decision problem into SOCRATES software following four primary tasks: Multi-Criteria Analysis, Equity Analysis, Local Sensitivity Analysis, and Global Sensitivity Analysis. Each task contains progressive steps to be completed to go through the evaluation (Figure 1). SOCRATES tasks and steps are both operational (data input) and informative (data reading and interpretation).

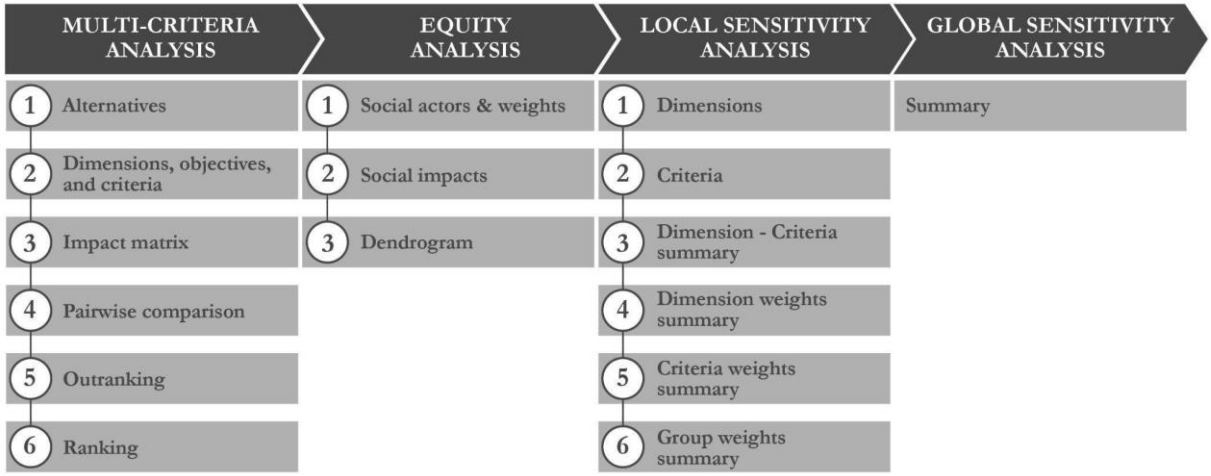
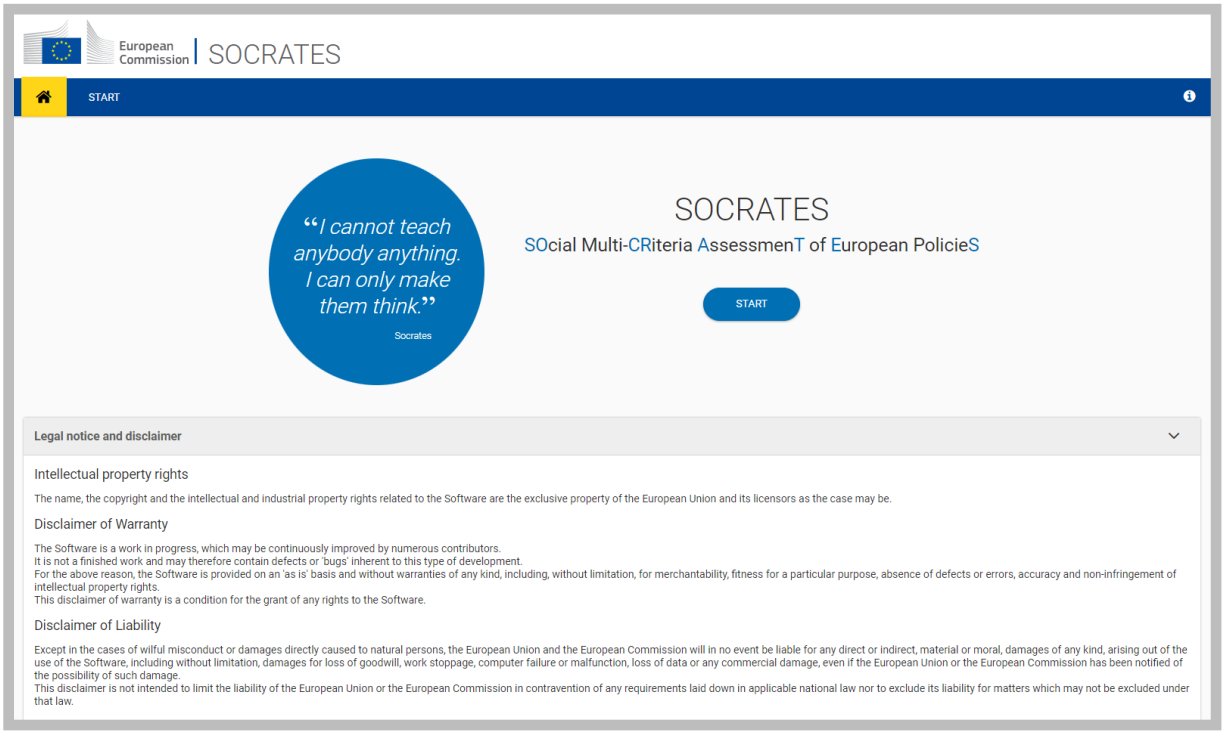


Figure 1 - SOCRATES workflow.

The software provides an interface that was designed according to the most modern concepts of man/machine interface (Screenshot 1), through advanced development of the typical elements that make up modern GUIs.



Screenshot 1 - SOCRATES' Graphical User Interface.

The application and its ways of use are presented in the remainder of this document. Basically, a very simple procedure is provided for the method, which is permanently visible in the upper half of each page of the tool.

4.1 Multi-Criteria Analysis

Multi-Criteria analysis requires the definition of relevant dimensions, objectives and criteria. It uses weights as importance coefficients and clarifies their role in the hierarchical structure. The impact matrix may include quantitative (including stochastic and/or fuzzy uncertainty) and qualitative (ordinal and/or linguistic) measurements of the performance of an alternative with respect to an evaluation criterion. It supplies a ranking of the alternatives according to the set of evaluation criteria (i.e. the technical compromise solution/s), computed by using a non-compensatory aggregation rule.

The multi-criteria analysis, which is performed on the impact matrix, is based on a comparison algorithm of the alternatives. This task presents six steps of data input, visualisation and interpretation of results (Figure 2).

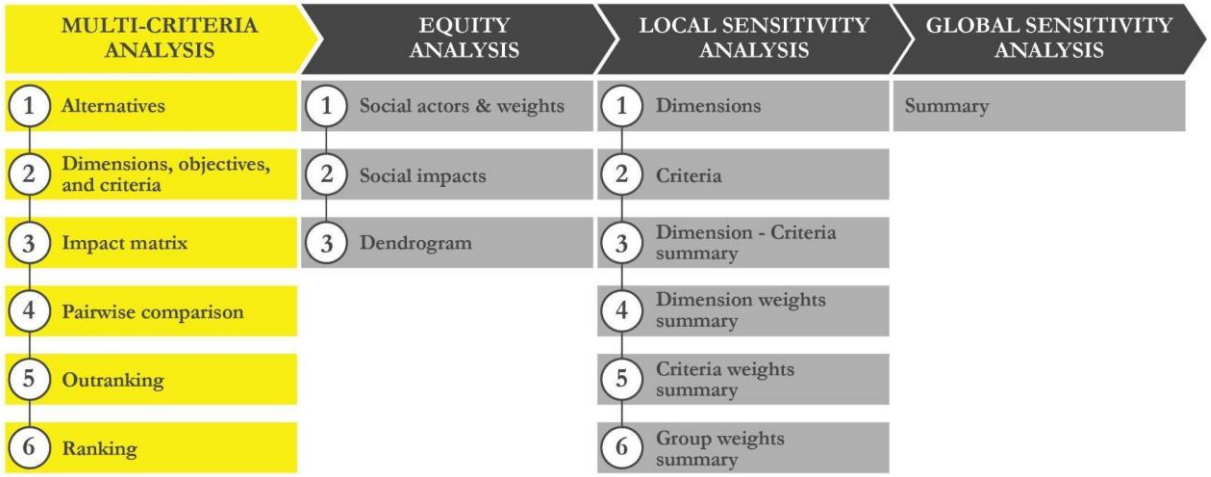
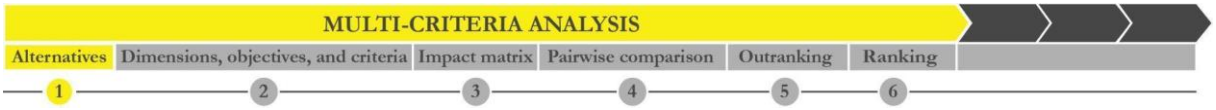


Figure 2 - SOCRATES first task: The Multi-Criteria Analysis in six steps.



What can you do in Step 1?

I can create and manage the **Alternatives**. To do it, I can:

Add Alternatives

This button allows you to create a new alternative

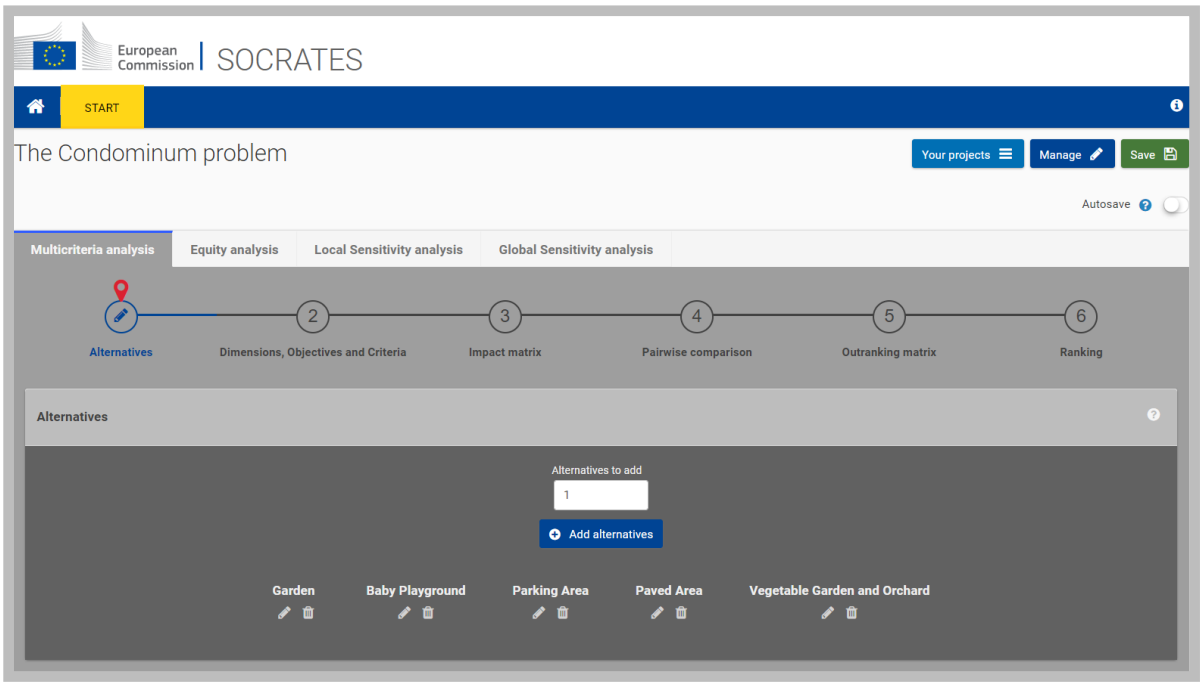
Manage Alternatives

This button allows you to edit the name of the alternative and add a brief description

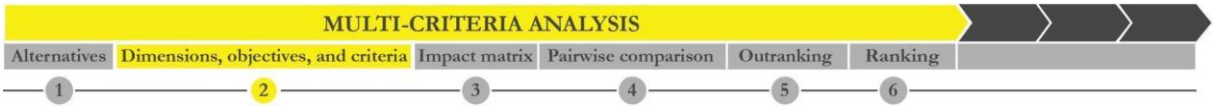
Delete Alternatives

This button allows you to delete an alternative

The Alternatives are the different possibilities from which a choice must be made. In the case of the Condominium problem, the Alternatives are: (1) Garden, (2) Baby Playground, (3) Parking Area, (4) Paved Area, and (5) Vegetable Garden and Orchard (Screenshot 2).



Screenshot 2 - Multi-Criteria Analysis. Step1: input of alternatives.



What can you do in Step 2?

I can create and manage the hierarchical structure of the decision problem by setting the **Dimensions, Objectives, and Criteria**. To do it, I can:

Add Dimension

This button allows you to create new Dimensions

Add Dimension

This button allows you to create new Dimensions using the pie chart graph

Add Objective/Add Criterion

This button allows you creating new items in the lower category in terms of Objectives (if you click on Add objective) and Criteria (if you click on Add criterion)

Manage

This button allows you to change the name of the category and add a brief description.

Weight

You can set the Weight of an item (referred to its Global Weights) using this scrollbar.

Move

This button allows you changing the order of items

Delete

This button allows you to delete an item (dimension, objective, criterion)

Dimensions

This button allows you to assign the same weight to all the Dimensions

Criteria

This button allows you assigning the same weight to all the Criteria

Zoom In

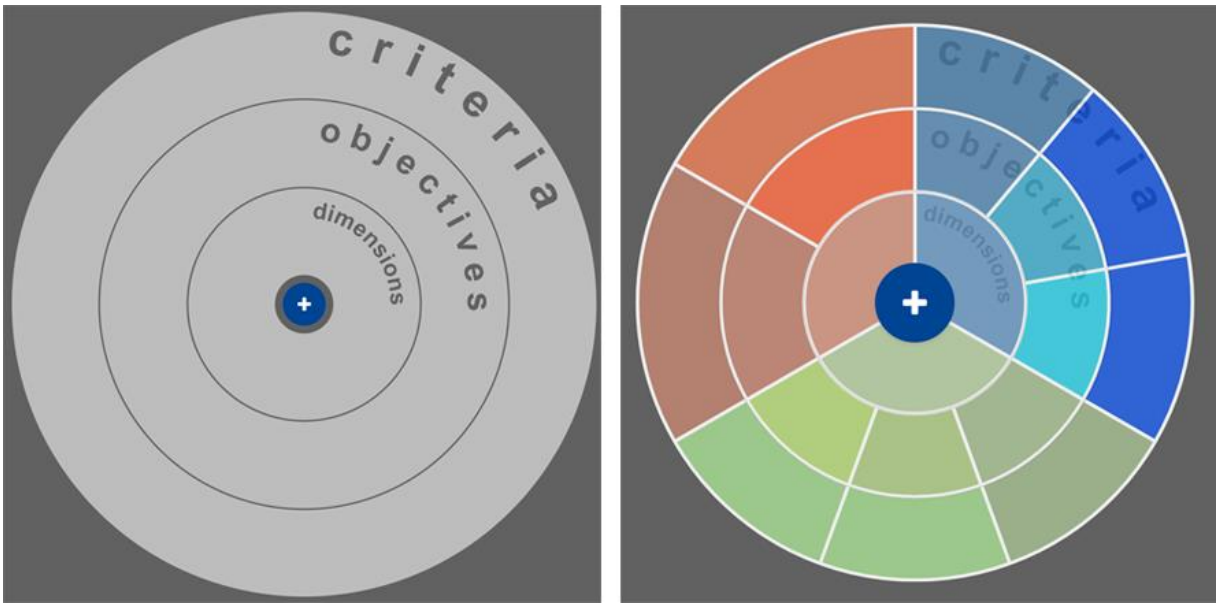
Clicking on the area related to a specific category within the pie chart you can visualise the specific branch of decision-problem and the hierarchical levels subordinated to it

Zoom Out

Clicking on Back you return to the pie chart original view

Once Alternatives have been defined in Step 1, SOCRATES requires the definition of Dimensions (e.g. economic, social, and environmental), Objectives, and Criteria. In this Step, you can also set the Weight of each category and sub-category, using the scroll bar. You can decide to attribute the same or different importance level.

The hierarchical structure of the decision-making problem is represented by a circular graph in which the higher category, corresponding to Dimension, which should be entered first, is the closest to the centre of the circle, then the Objectives and then the Criteria. All changes made to the structure of the model in the table are also applied to the pie chart on the left side and vice versa.



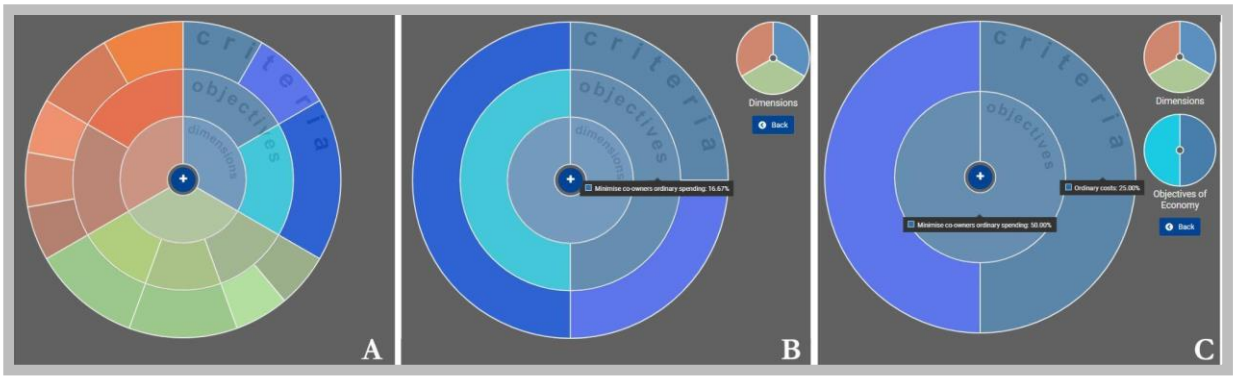
Screenshot 3 - Multi-Criteria Analysis. Step 2: categories pie chart.

Figure 3 shows the hierarchical structure of the "Condominium problem" example which is divided into three Dimensions, seven Objectives, and twelve Criteria.

DIMENSIONS	OBJECTIVES	CRITERIA	DIR.	EVAL. SCALE
Economy	Minimise co-owners ordinary spending	Ordinary costs	↓	€
		Extra-ordinary costs	↓	€
	Maximise apartments' real estate values	Mean apartments income	↑	€/sqm
Society	Valorising housing common areas	Recreation spaces	↑	Good/Bad
		Shared facilities	↑	num.
	Reducing disagreements among neighbours	Legal disputes	↓	+++/---
	Taking care of common spaces	Willingness to take care of common spaces	↑	+++/---
Environment	Improving environment comfort	Healthy air	↑	Good/Bad
		Noise level	↓	decibel
		Climate mitigation	↑	Good/Bad
	Optimising waste management	Community composting	↑	+++/---
		Recycling capacity	↑	Good/Bad

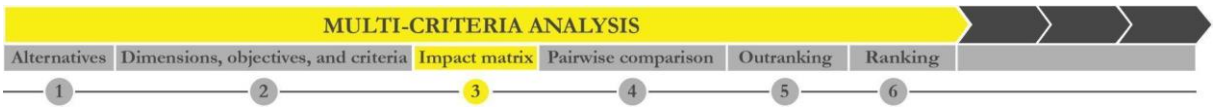
Figure 3 - Dimensions, Objectives, and Criteria of the "Condominium problem".

Dimensions, Objectives and Criteria Weights are displayed graphically as shown in Screenshot 4-A, where it is possible to see an example of equally weighted Dimensions.



Screenshot 4 – Multi-Criteria Analysis. Step 2: zooming into categories pie chart.

To have a closer look at certain sections of the pie chart, it is possible to **Zoom In**. If you click on a specific category, all levels below it are displayed (Screenshots 4-B and 4-C). **Zoom Out** can be done by clicking on the item you have previously zoomed into. To return to the pie chart's original view, please click on **Back**.



What can you do in Step 3?

I can fully configure the **Impact matrix**. To do it, I can:

Add Alternatives (in addition to those created in the Step 1)

Manage Alternatives

This button allows you changing the name of Alternatives and add a brief description

Delete

This button allows you to delete Alternatives

Manage Criteria

This button allows you to enter in a drop down menu where you can:

Set the *Score Type* (**Quantitative**, **Qualitative**),

Access to the *Advanced options* (please see Section 5.1 for more details)

Select *Goal Type/Scale*

Thresholds

This button allows you to set the preference and indifference thresholds of Criteria

Import

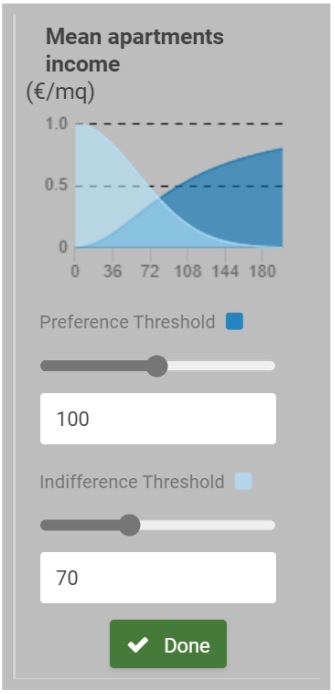
This button allows you importing the Impact Matrix as a csv file

The **Impact Matrix** presents, in a structured way, the information on the various Criterion Scores, i.e. each element of the matrix represents the performance of each Alternative according to each Criterion.

The Impact (Criteria/Alternatives) Matrix is presented, where the columns contain Alternatives, which were defined on the previous step, and the rows contain Criteria (Screenshot 6). Firstly, you have to input the value associated with each Criterion according to each Alternative. Qualitative or quantitative values can be selected.

In the case of a **Quantitative** variable, you must specify the ***Measurement unit*** and choose the direction of each Criterion concerning the overall objective (to Minimize or Maximize) in the ***Goal Type*** Section. The *Goal Type* of a Criterion clarifies whether a higher value of a Criterion corresponds to better (Maximization) or worse (Minimization) performance of the regarded alternative. In the case of a **Qualitative** linguistic variable, you must select a ***Scale*** choosing "Good/Bad" or "++/-". Clicking on the **Manage** button, you can also set **Advanced Options** (for further information you can refer to Section 5).

Additionally, only in the case of Quantitative variables, you can set the preference and indifference **Thresholds**. This button only works after inserting the scores in the impact matrix. More specifically, you can modify the preference and indifference relations by directly assigning it a numerical value or graphically by moving the scrollbars. The blue lines and areas represent the indifference and preference functions and illustrate the corresponding threshold at a 0.5 line. The dark blue illustrates the preference function while light blue represents the indifference function (see Screenshot 5). The preference value must be higher than the value for indifference. The x-axis shows the difference between two alternatives, whereas the y-axis shows the credibility of the preference/indifference relation. In case of Qualitative Criteria, you do not need to set thresholds.

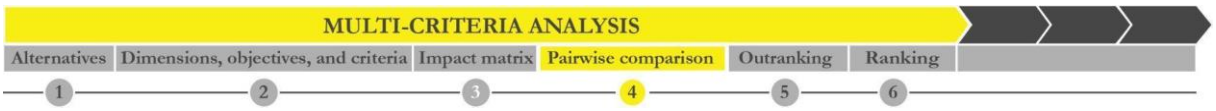


Screenshot 5 - Preference and Indifference Thresholds.

The impact matrix presents the values of the criteria in relation to the alternatives (Screenshot 6). In the case of the "Condominium problem", Criteria are both quantitative and qualitative, with different unit of measurement and impact direction, as shown in Figure 3.

	Garden	Baby Playground	Parking Area	Paved Area	Vegetable Garden and Orchard
Ordinary costs (€/year)	4000	6000	300	500	5000
Extra-ordinary costs	800	500	100	150	2000
Mean apartments income (€/mq)	1600	1550	1520	1500	1700
Recreation spaces	Good	Good	Fairly Bad	Fairly Bad	Very Good
Shared facilities (Number)	1	2	1	0	5
Legal disputes	=	=	++	=	++
Willingness to take care of common spaces	++	++	-	---	+++
Healthy air	Very Good	Neutral	Very Bad	Very Bad	Very Good
Noise level (decibel)	20	100	70	30	40
Climate mitigation	Very Good	Fairly Bad	Very Bad	Bad	Very Good
Community composting	+	-	-	-	+
Recycling capacity	Good	Neutral	Bad	Bad	Very Good

Screenshot 6 - Multi-Criteria Analysis. Step3: Impact Matrix.



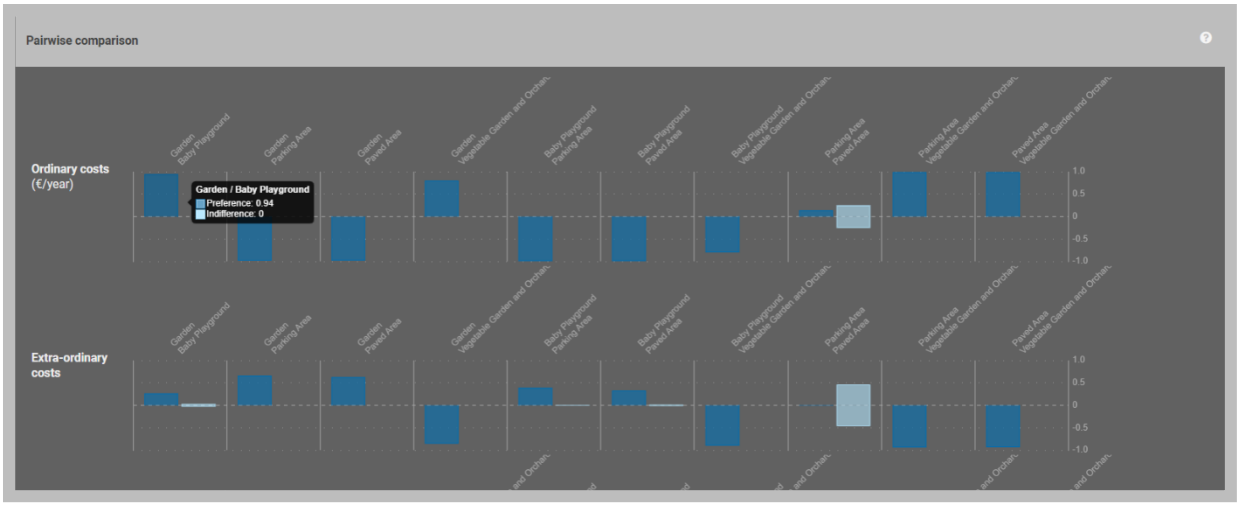
What can you do in Step 4?

I can read the results of the **Pairwise comparison**. To do it, I can:

Visualise the pairwise comparison of alternatives according to each criterion.

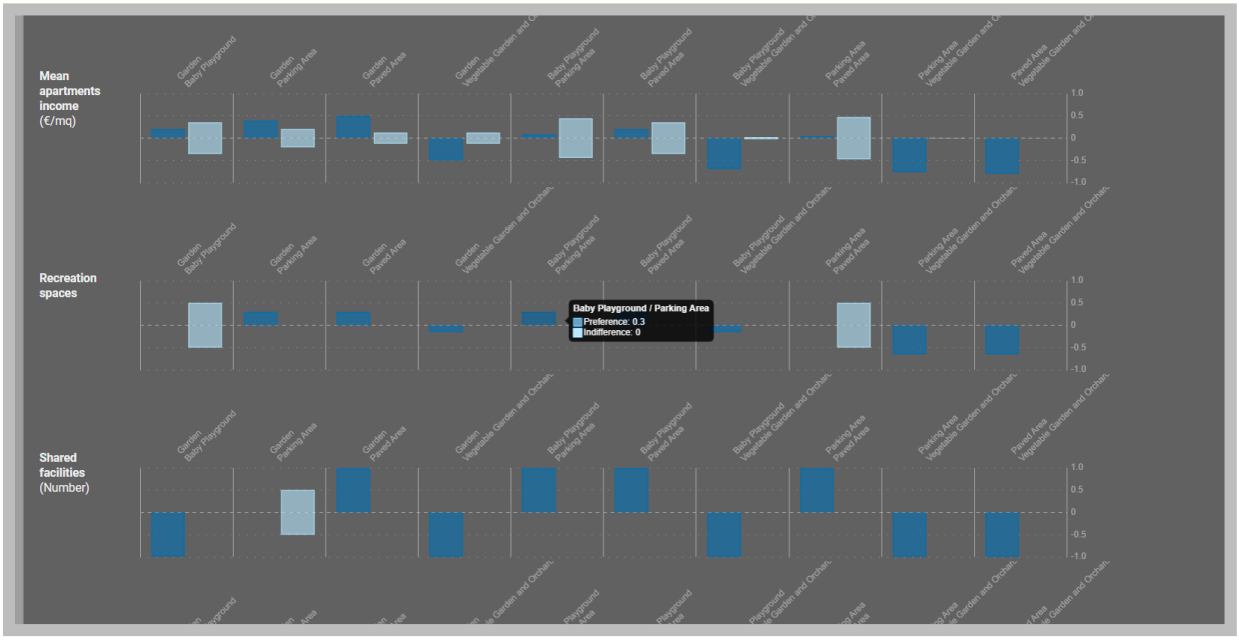
Move the cursor onto bars to display indifference and preference thresholds.

After filling in values into the impact matrix, the pairwise comparison step serves as a tool to illustrate which alternatives are preferred when using certain preference and indifference thresholds on each single criterion. The dark blue illustrates the preference threshold while light blue represents the indifference threshold. The larger the dark blue bar, the higher the difference between two alternatives. The larger the light blue bar, the higher the credibility of an indifference relation.



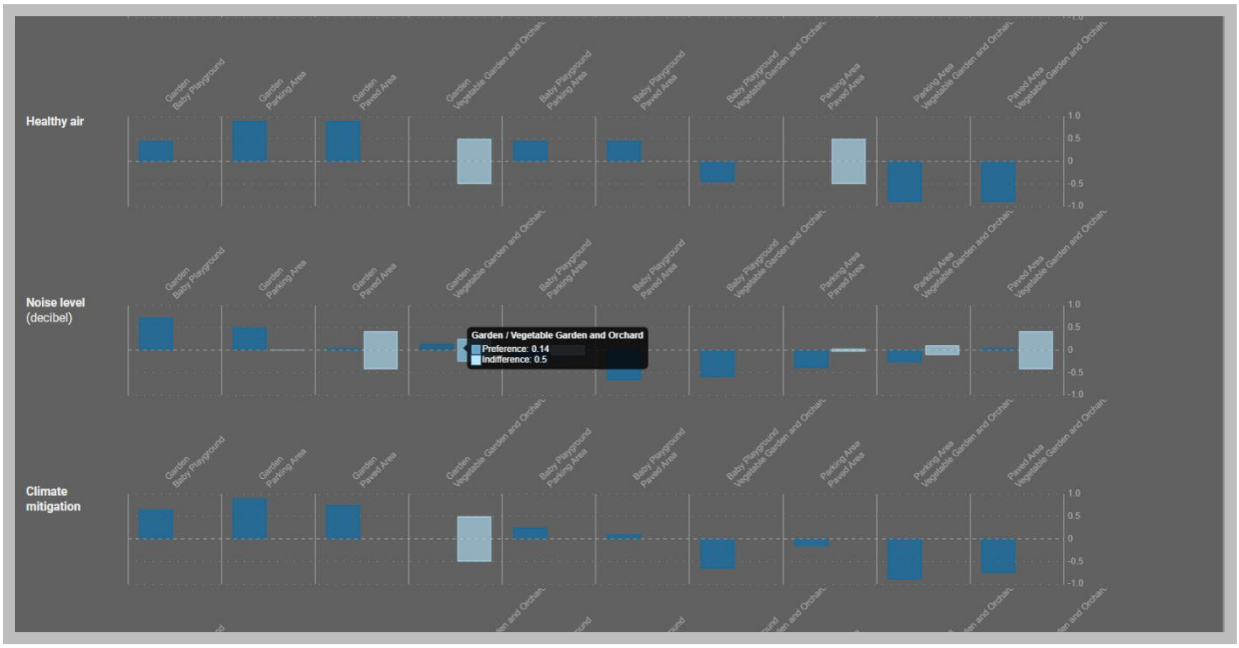
Screenshot 7 - Multi-Criteria Analysis. Step 4: Pairwise comparison. Bar charts showing pairwise comparisons among alternatives according to *Ordinary Costs* and Extra-*ordinary Costs*. Visualization of preference and indifference relations.

According to the criterion "Ordinary costs", there is a clear preference of alternative "Garden" to alternative "Baby Playground", since the value filled in the impact matrix for "Garden" (4000 €/year) is lower than the corresponding value for "Baby Playground" (6000 €/year). No level of indifference can be seen for these alternatives. On the contrary, a certain degree of indifference can be observed due to the predefined indifference relation and the small differences in ordinary costs between "Parking Area" and "Paved Area". It can be also seen that alternative "Parking Area" (ordinary costs = 300 €/year) is a bit better than the other alternative (500 €/year).



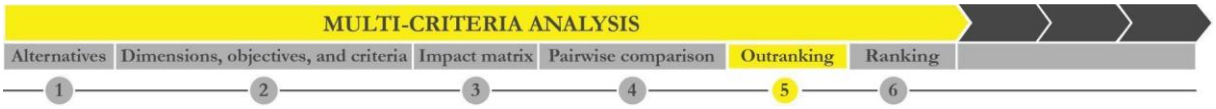
Screenshot 8 - Multi-Criteria Analysis. Step 4: Pairwise comparison. The bar charts show the pairwise comparisons among alternatives according to *Mean apartments income*, *Recreation spaces* and *Shared facilities*. Visualization of preference and indifference relations.

When looking at the Recreation spaces criterion, it becomes clear due to the linguistic qualitative scores, that "Vegetable Garden and Orchard" (Very Good) is favored compared to "Parking Area" (Fairly Bad).



Screenshot 9 - Multi-Criteria Analysis. Step 4: Pairwise comparison. The bar charts show pairwise comparisons among alternatives according to *Healthy air*, *Noise level* and *Climate mitigation*. Visualization of preference and indifference relations.

After the computation of the indifference and preference relations, and by considering the criterion weights, an outranking matrix can be obtained.



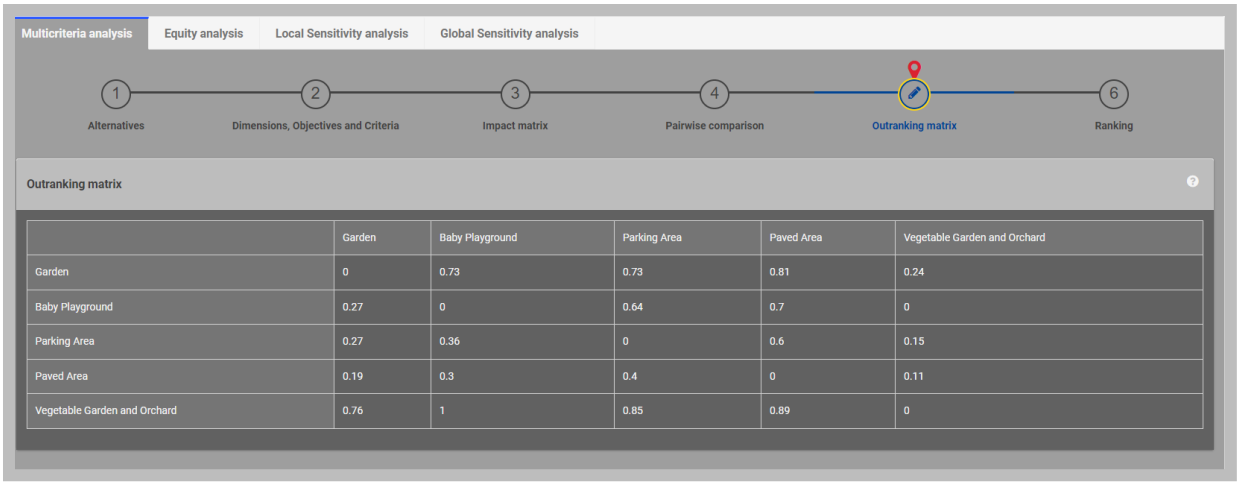
What can you do in Step 5?

I obtained the results of the **Outranking** matrix. I can:

Visualise the outranking matrix

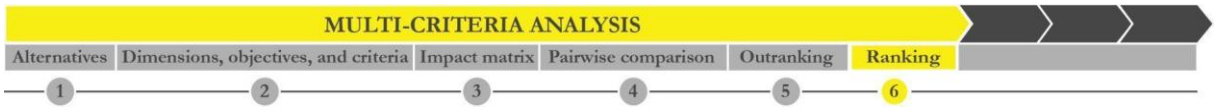
After defining measures on the performance of given alternatives, weights (importance) attached to each criterion of interest and the definition of the direction concerning the criterion's objective, SOCRATES builds up an outranking matrix. It provides an illustrative visualisation of how one alternative compares against another one, taking into account all the criteria.

In the Condominium example-related table, under the assumption of equal dimensions weights, it can be noticed that for example, "Garden" outperformed "Baby Playground" for about 2/3 of the criterion weights, and "Vegetable Garden and Orchard" proves to be better than "Garden" for a similar percentage of the total criterion weights. "Vegetable Garden and Orchard" is better than "Baby Playground" for all the criteria taken into consideration. (Screenshot 10).



	Garden	Baby Playground	Parking Area	Paved Area	Vegetable Garden and Orchard
Garden	0	0.73	0.73	0.81	0.24
Baby Playground	0.27	0	0.64	0.7	0
Parking Area	0.27	0.36	0	0.6	0.15
Paved Area	0.19	0.3	0.4	0	0.11
Vegetable Garden and Orchard	0.76	1	0.85	0.89	0

Screenshot 10 - Multi-Criteria Analysis. Step 5: Outranking Matrix.



What can you do in Step 6?

I can read the final **Ranking**. To do it, I can:

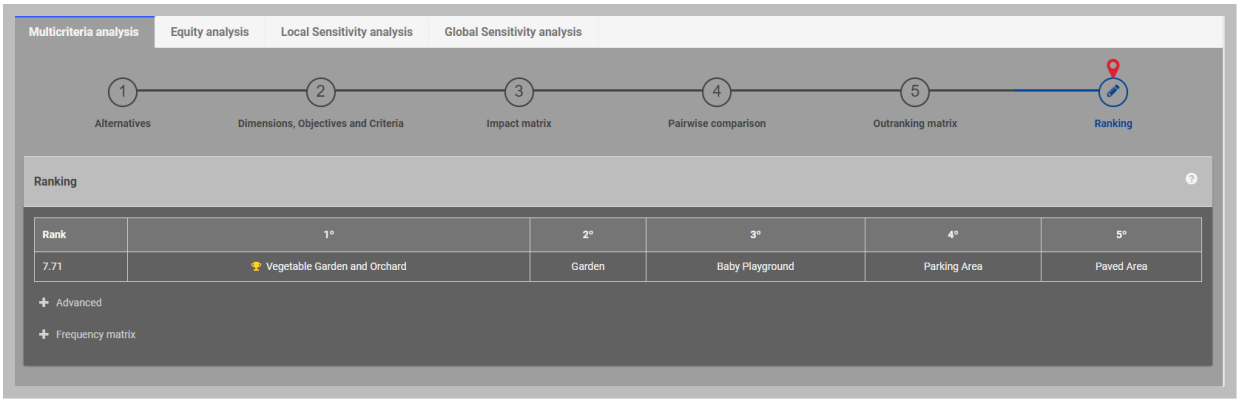
Visualise the final ranking

Open **Advanced** options

Display the Borda loser in ranking (please see Section 5.2 for more details)

Display the frequency matrix (please see Section 5.2 for more details)

The application of a mathematical aggregation rule on the information contained in the impact matrix generates the final ranking of the alternatives (i.e. the technical compromise solution/s). The winning alternative for the case of the Condominium common area results in the Vegetable Garden and Orchard, followed by the Garden, the Baby Playground, the Parking Area, and the Paved Area (Screenshot 11). It is computed by using a non-compensatory aggregation rule.



Screenshot 11 - Multi-Criteria Analysis. Step 6: Ranking.

4.2 Equity analysis

Equity analysis requires as input a set of social actors and the qualitative or quantitative assessment of the alternatives considered in the Multi-Criteria Analysis. Weights to social actors can be attached if needed; the starting point is the equal weighting assumption. The Equity Analysis consists of 3 Steps (Figure 4). The Step 1, Social actors and weights, defines who are the groups involved in the decision-making process and their weight (importance) in the decision.

The Social impacts matrix contains the assessment (qualitative in the form of linguistic variables, ++/-, ordinal scores or quantitative in the form of numeric scores) of each social actor on the whole set of alternatives considered; the Dendrogram of coalition illustrates similarities and divergences among them.

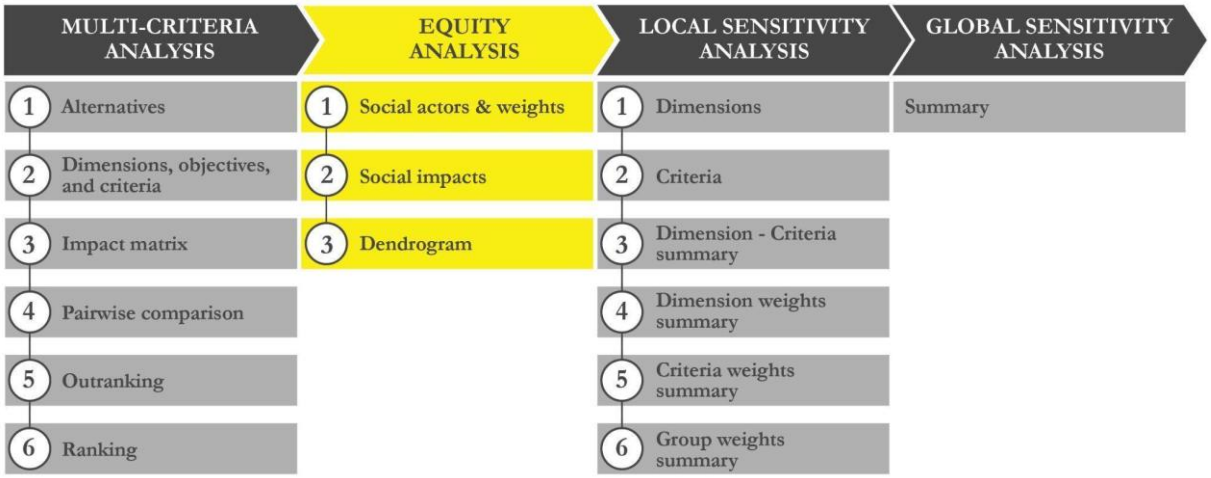


Figure 4 - SOCRATES second task: the Equity Analysis in 3 steps.

Thus, the equity analysis produces the following information:

- indications of the distance of the positions of the various social groups (i.e. possibilities of convergence of interests or coalition formations);
- ranking of the alternatives according to actors' impacts or preferences (social compromise solution).

The decision-making process can also be iterated by adding further compromise alternatives in Step 2 of the equity analysis. If you add an alternative in this task, do not forget to return to Step 3 in Multi-Criteria Analysis to complete the Impact Matrix.

What can you do in Step 1?

I can define **Social actors and weights**. To do it, I can:

Add group

Add a group of social actors in the decision model

Groups

Assign the same weight to all the groups

Weight

Change the weight of each group moving the scroll bar

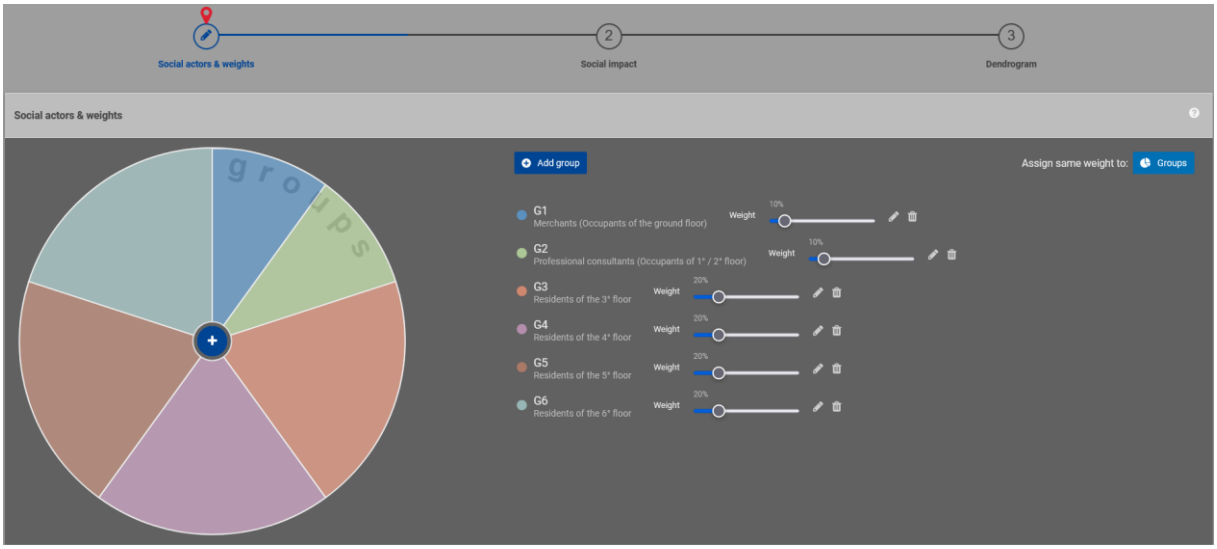
Manage

Allow to enter name and description of a group

Delete

Delete a group

In this step, you can add social actors' groups and manage their relative importance (weight) in the decision making by moving the scroll bar (Screenshot 12).



Screenshot 12 - Equity Analysis. Step 1: Social actors and weights.

What can you do in Step 2?

I can define the **Social impacts** through the Equity Matrix. To do it, I can:

Add alternative

Insert new alternatives to the decision problem

Manage Groups

Enter the name and description, and set a qualitative evaluation scale for a group

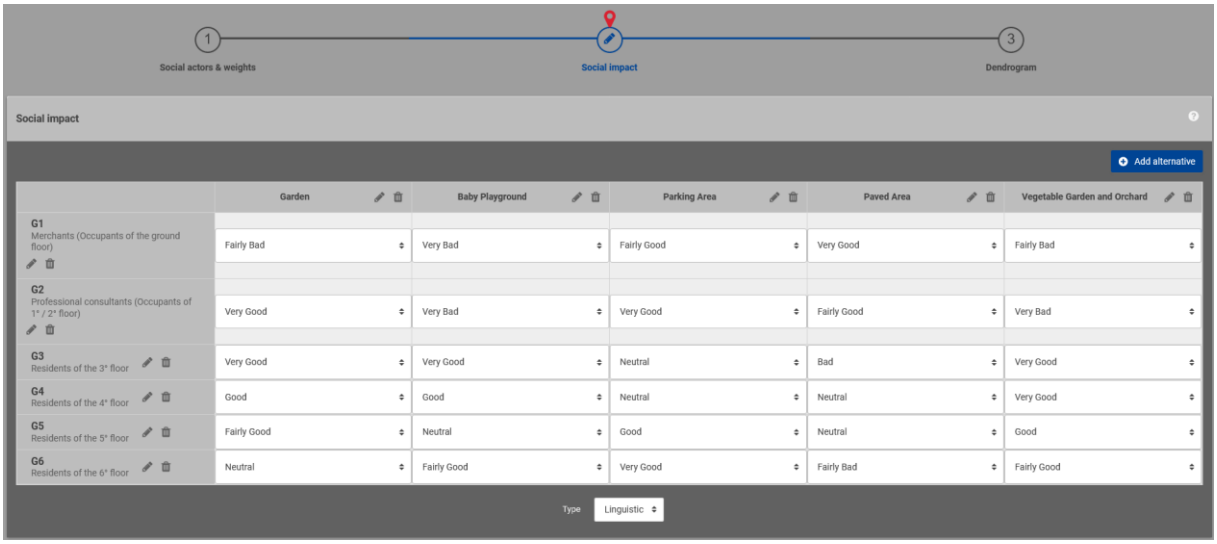
Manage Alternatives

Enter the name and description of an alternative

Delete

Delete groups or alternatives

The core part of this step consists in managing the Groups. If you add an alternative to the Equity Matrix, you can manage the name and description. First, you must select **one of the three qualitative evaluation scales** linguistic variables (From "Very Good" to "Very Bad", Plus/Minus (from "+++" to "---") or ordinal scores (1-st, 2-nd, third, etc.), or the **quantitative numeric scores**. Thus, you must enter the value of each group preference for each alternative to complete the Equity Matrix (Screenshot 13).



Screenshot 13 - Equity Analysis. Step 2: The social impact matrix.

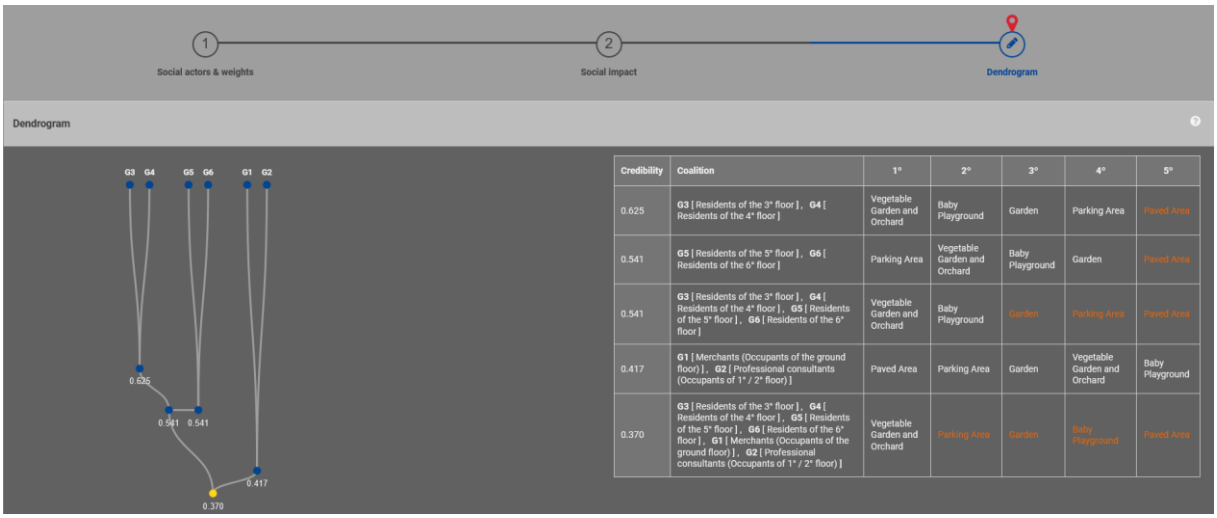
What can you do in Step 3?

I can appreciate the **Dendrogram** of actors' coalitions. To do it, I can:

Visualise graphical rankings and actors coalitions through the dendrogram

Select nodes of the dendrogram

The Dendrogram highlights possible coalition formation for decreasing values of the similarity index. The credibility score value is directly proportional to the convergence between the different groups of social actors; as it decreases, so does the degree of convergence (Screenshot 14). The Dendrogram of coalitions depends only on the information contained in the Social Impact matrix (Step 2), while the ranking of alternatives may change according to the weight attached to the Groups.



Credibility	Coalition	1°	2°	3°	4°	5°
0.625	**G3** [Residents of the 3° floor], **G4** [Residents of the 4° floor]	Vegetable Garden and Orchard	Baby Playground	Garden	Parking Area	Paved Area
0.541	**G5** [Residents of the 5° floor], **G6** [Residents of the 6° floor]	Parking Area	Vegetable Garden and Orchard	Baby Playground	Garden	Paved Area
0.541	**G3** [Residents of the 3° floor], **G4** [Residents of the 4° floor], **G5** [Residents of the 5° floor], **G6** [Residents of the 6° floor]	Vegetable Garden and Orchard	Baby Playground	Garden	Parking Area	Paved Area
0.417	**G1** [Merchants (Occupants of the ground floor)], **G2** [Professional consultants (Occupants of 1° / 2° floor)]	Paved Area	Parking Area	Garden	Vegetable Garden and Orchard	Baby Playground
0.370	**G3** [Residents of the 3° floor], **G4** [Residents of the 4° floor], **G5** [Residents of the 5° floor], **G6** [Residents of the 6° floor], **G1** [Merchants (Occupants of the ground floor)], **G2** [Professional consultants (Occupants of 1° / 2° floor)]	Vegetable Garden and Orchard	Parking Area	Garden	Baby Playground	Paved Area

Screenshot 14 - Equity Analysis. Step 3: The Dendrogram of coalitions.

In the Condominium problem example, all Residents have equal importance (weight) in the final decision, while Merchants and Professional consultants have less weight (Screenshot 12). All the groups converge on Vegetable Garden and Orchard with a credibility threshold of 0.370. The alternatives in red colour are those with the highest conflict.

4.3 Local Sensitivity analysis

The objective of **sensitivity analysis** is to check if the rankings provided are stable and to determine which of the input parameters influence the model output. *Local sensitivity analysis* looks at the sensitivity of results to a) the exclusion/inclusion of different criteria and dimensions and b) dimensions, criteria or social actors weight changes; all parameters are changed one per time. This task presents six steps of visualisation and interpretation of results (Figure 5).

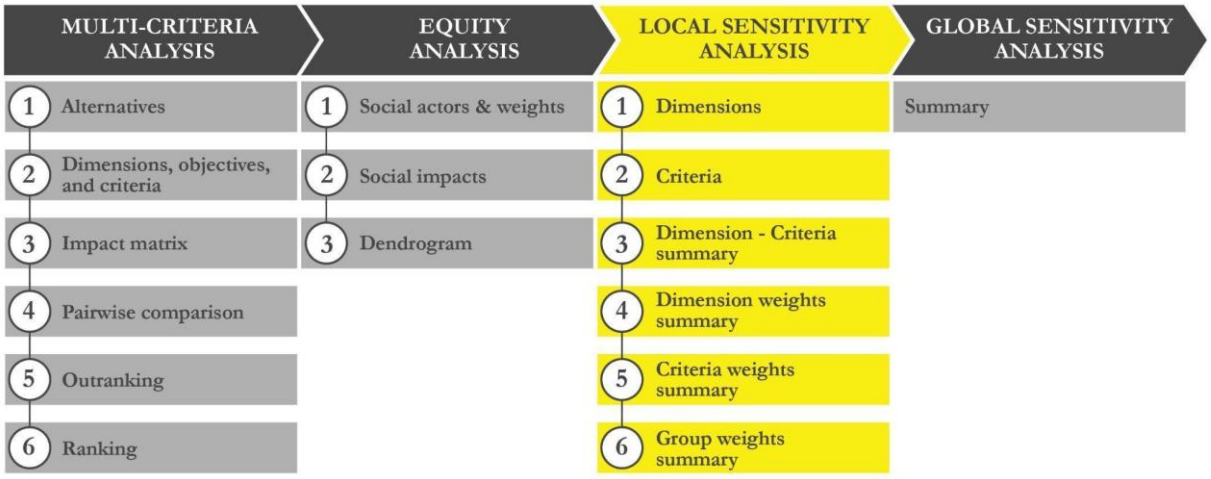
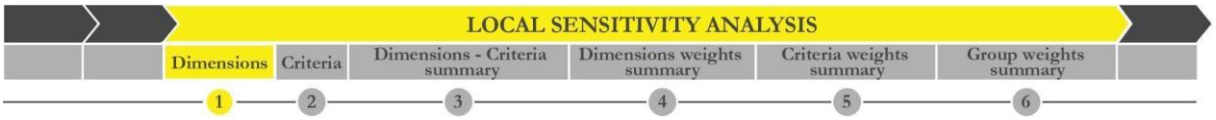


Figure 5 - SOCRATES third task: The Local Sensitivity Analysis in six steps.



What can you do in Step 1?

I can check the robustness of the original ranking to the exclusion/inclusion of different **Dimensions**, one by one. To do it, I can:

Visualise the original ranking and the local rankings per each dimension

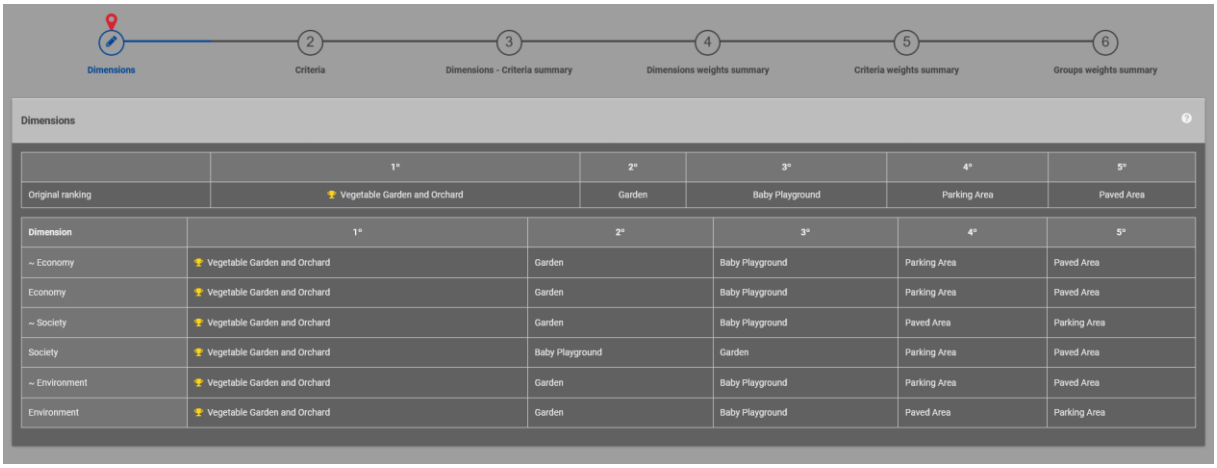
Identify the winner alternative

Identify the winner alternative for that specific ranking

You can visualise the *Original ranking* at the top of the screen, while the lower table contains the local rankings produced when you exclude (~) one dimension or when one dimension only is used (Screenshot 15).

The dimension row accompanied by the tilde (~) indicates a ranking that computes all Dimensions excluding the indicated one (e.g. The "~ Economy" row shows the ranking obtained by excluding the *Economy* dimension). Instead, the row of the indicated dimension represents the ranking obtained

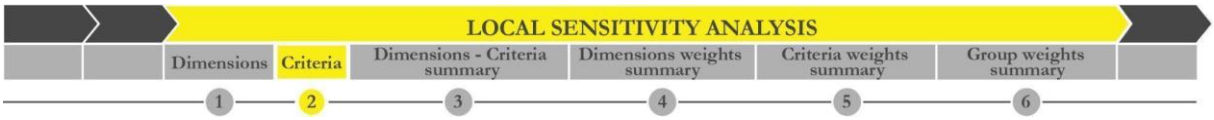
considering only that dimension (e.g. The "Economy" row shows the ranking by including only the *Economy* dimension).



	1°	2°	3°	4°	5°
Original ranking	Vegetable Garden and Orchard	Garden	Baby Playground	Parking Area	Paved Area

Dimension	1°	2°	3°	4°	5°
~ Economy	Vegetable Garden and Orchard	Garden	Baby Playground	Parking Area	Paved Area
Economy	Vegetable Garden and Orchard	Garden	Baby Playground	Parking Area	Paved Area
~ Society	Vegetable Garden and Orchard	Garden	Baby Playground	Paved Area	Parking Area
Society	Vegetable Garden and Orchard	Baby Playground	Garden	Parking Area	Paved Area
~ Environment	Vegetable Garden and Orchard	Garden	Baby Playground	Parking Area	Paved Area
Environment	Vegetable Garden and Orchard	Garden	Baby Playground	Paved Area	Parking Area

Screenshot 15 – Local Sensitivity Analysis. Step 1: Robustness analysis according to the inclusion/exclusion of the Dimensions.



What can you do in Step 2?

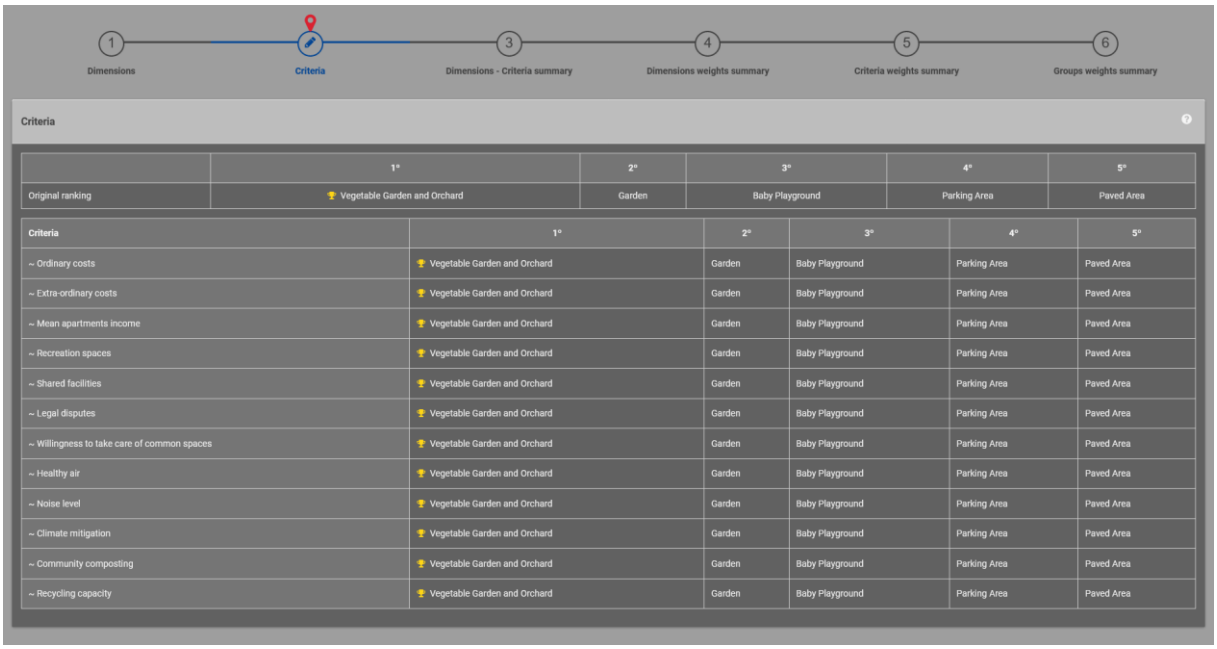
I can check the robustness of the original ranking to the exclusion of each **Criterion**, one by one. To do it, I can:

Visualise the original ranking and the local rankings excluding criteria one by one

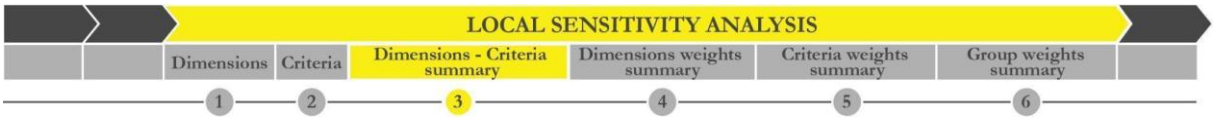
Identify the winner alternative

Identify the winner alternative for that specific ranking

You can visualise the *Original ranking* at the top of the screen, like in the previous Step, while the lower table contains the local rankings produced when you exclude (~) one criterion at once (Screenshot 16). In the Criteria table, you can appreciate the ranking stability. In the example of the "Condominium problem", local rankings are always the same, but in other cases, they may change.



Screenshot 16 - Local Sensitivity Analysis. Step 2: Robustness analysis according to the inclusion/exclusion of the Criteria.



What can you do in Step 3?

I can read a **Dimensions - Criteria summary**. To do it, I can:

Visualise the original ranking and the *Dimensions - Criteria summary* matrix

Identify the winner alternative

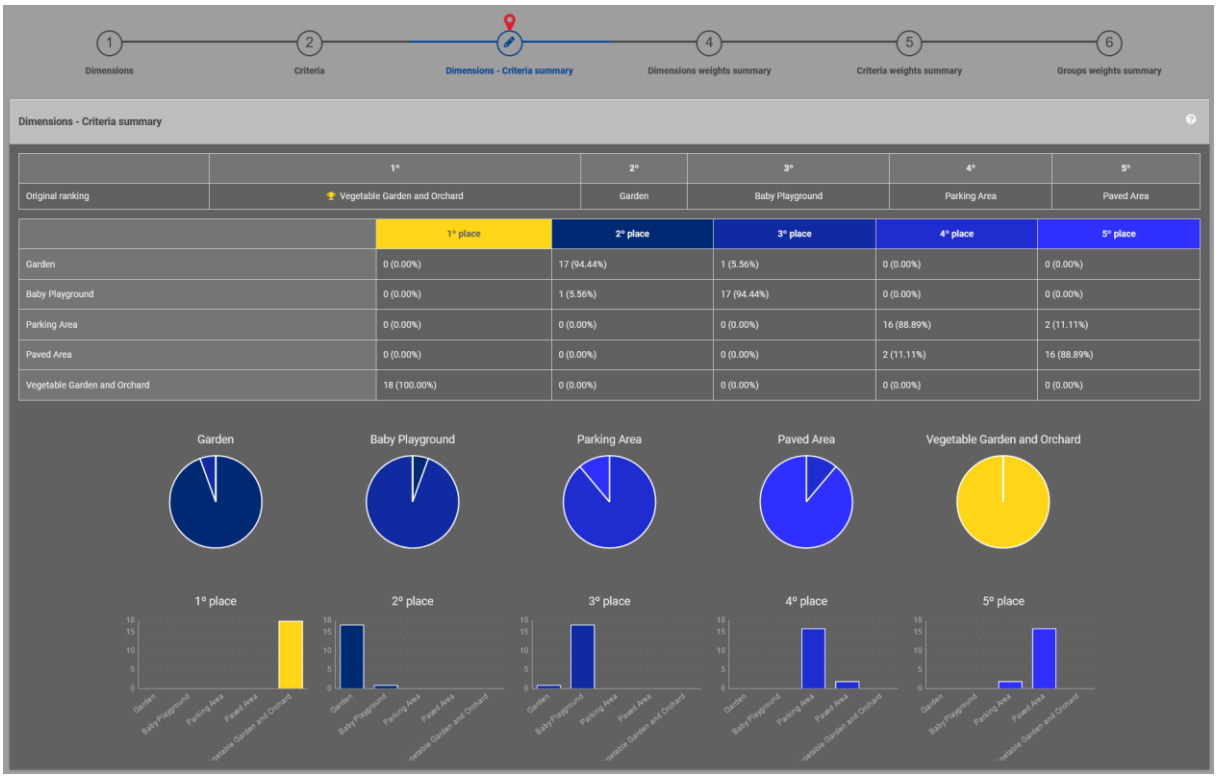
Visualise the normalised values of the matrix in pie charts

Visualise the absolute values of the matrix in bar charts

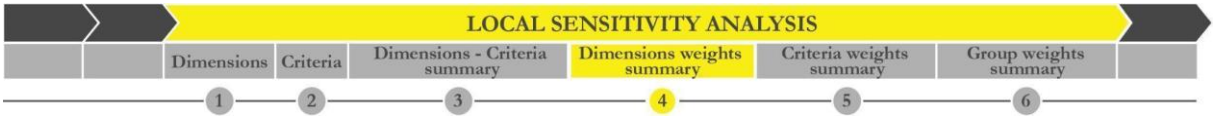
Scroll the cursor up the bar charts and pie charts to display how many times an alternative is placed in each ranking position

If you look at the rows, you can see how many times each Alternative is present in each ranking position (both in absolute and relative terms). On the contrary, each column shows how each ranking position is divided among the various alternatives (in absolute and relative terms). In the example,

indeed, the “Vegetable Garden and Orchard” seats at the first position 18 times which is the frequency of 100% (Screenshot 17).



Screenshot 17 - Local Sensitivity Analysis. Step 3: Robustness analysis according to Dimensions - Criteria summary.



What can you do in Step 4?

I can see how the results change when the weight of one dimension increases and that of the other dimensions remains equally distributed. To do it, I can:

Visualise the original ranking and the *Dimensions weights summary*

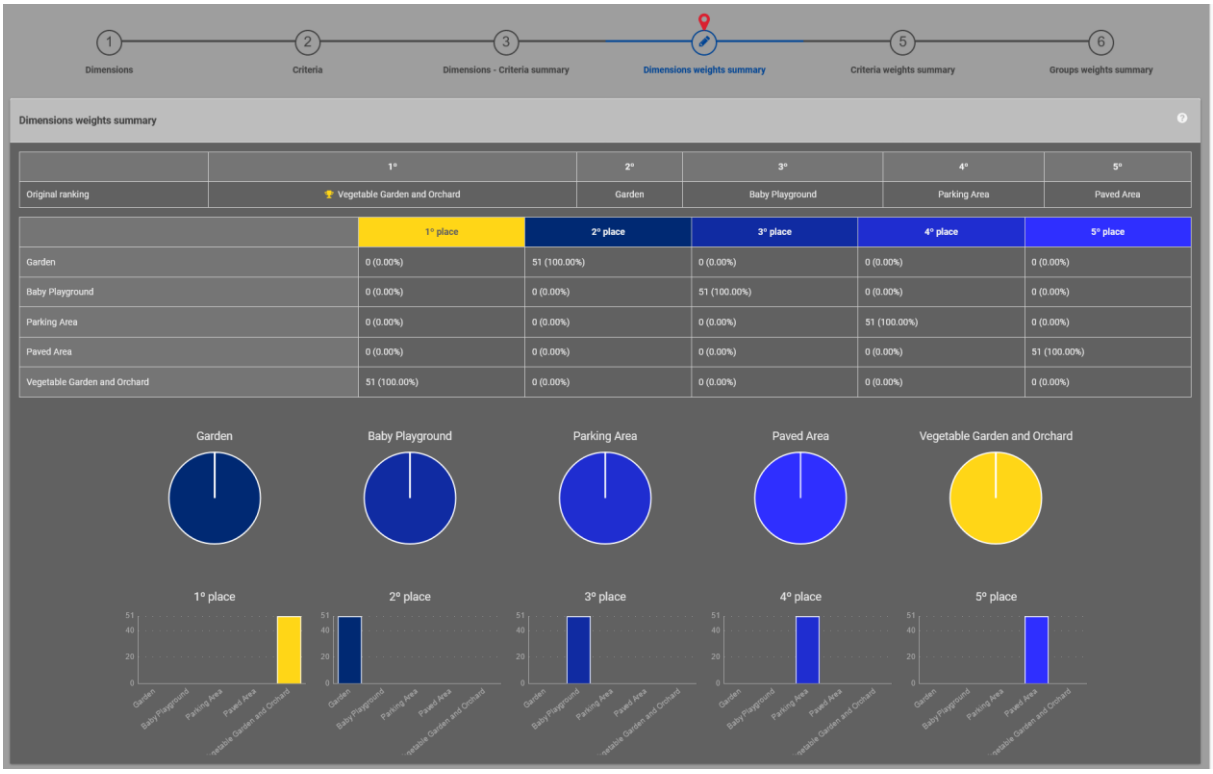
Identify the winner alternative

Visualise the normalised values of the matrix in pie charts

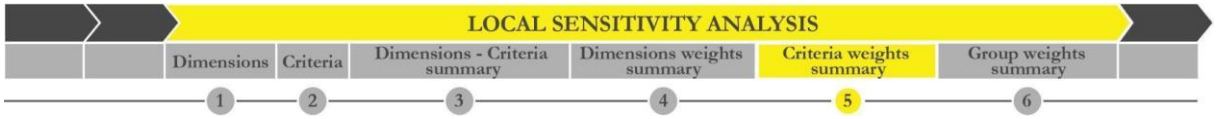
Visualise the absolute values of the matrix in bar charts

Scroll the cursor up the bar charts and pie charts to display how many times an alternative is placed in each ranking position

If you look at the rows, you can see how many times each Alternative is present in each ranking position (both in absolute and relative terms). On the contrary, each column shows how each ranking position is divided among the various alternatives (in absolute and relative terms). As the example shows, the ranking remains robust if you increase, one at a time, the weight of dimension up to 50% (Screenshot 18). The Vegetable Garden and Orchard alternative remains always in 1st place. The same stability applies to all the other positions in the ranking.



Screenshot 18 - Local Sensitivity Analysis. Step 4: Robustness analysis according to Dimension weights summary.



What can you do in Step 5?

I can see how the results change when the weight of one Criterion increases and that of the other Criteria remains equally distributed. To do it, I can:

Visualise the final ranking and the *Criteria weights summary*

Identify the winner alternative

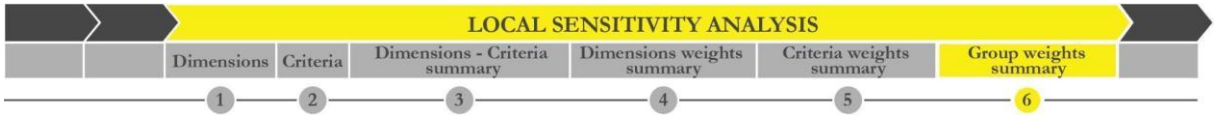
Visualise the normalised values of the matrix in pie charts

Visualise the absolute values of the matrix in bar charts

Scroll the cursor up the bar charts and pie charts to display how many times an alternative is placed in each ranking position

If you look at the rows, you can see how many times each Alternative is present in each ranking position (both in absolute and relative terms). On the contrary, each column shows how each ranking position is divided among the various alternatives (in absolute and relative terms). SOCRATES increases the weight of one criterion till a maximum of 0.5 and distributes those of the others equally, to check the original ranking robustness. Looking at the example (Screenshot 19), you can notice that Vegetable Garden and Orchard placed at the first position 503 times (99.8%).

Screenshot 19 - Local Sensitivity Analysis. Step 5: Robustness analysis according to Criteria weights summary.



What can you do in Step 6?

I can see how the results change when the weight of one Group of social actors increases and that of the other groups remains equally distributed. To do it, I can:

Visualise the final ranking and the *Group weights summary*

Identify the winner alternative

Visualise the normalised values of the matrix in pie charts

Visualise the absolute values of the matrix in bar charts

Scroll the cursor up the bar charts and pie charts to display how many times an alternative is placed in each ranking position

If you look at the rows, you can see how many times each Alternative is present in each ranking position (both in absolute and relative terms). On the contrary, each column shows how each ranking position is divided among the various alternatives (in absolute and relative terms). Looking at the example (Screenshot 20), you can notice that "Vegetable Garden and Orchard" placed at the first position only 6 times (2.94%), while "Parking Area" results in the first position 153 times (75%), "Garden" is first 45 times (22.06%). As one can see, in this case results are very sensitive to weight changes.

Screenshot 20 - Local Sensitivity Analysis. Step 6: Robustness analysis according to Group weights summary.

4.4 Global Sensitivity analysis

Global sensitivity analysis focuses on all the possible combinations of criterion weights; all weights are changed simultaneously and extreme values are considered too (each single weight may vary in the whole range 0 -1). The whole information produced by the global sensitivity analyses is synthesized into simple graphics.

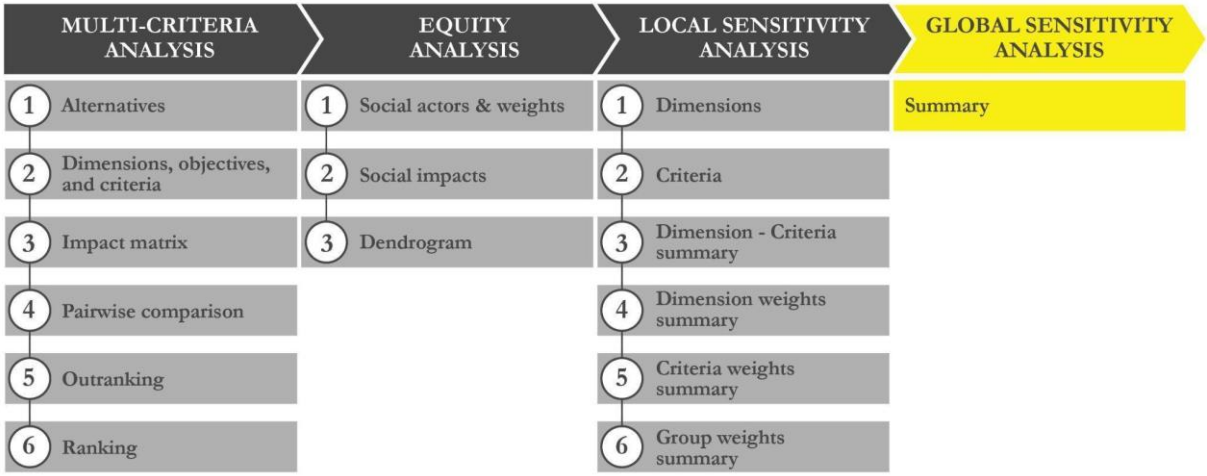


Figure 6 - SOCRATES fourth task: The Global Sensitivity Analysis.

What can you do at the end?

I can see how the results change when all the parameters in the model are changed simultaneously. To do it, I can:

Visualise the original ranking and how many times an alternative goes in each ranking position.

Visualise the normalised values of the matrix in pie charts

Visualise the absolute values of the matrix in bar charts

Advanced option

Set the *Sobol value* (please see Section 5.3 for more details)

The Global Sensitivity Analysis summary is synthesised in this step through the table and the charts, like in the Local Sensitivity Analysis. If you look at the rows, you can see how many times each Alternative is present in each ranking position (both in absolute and relative terms). On the contrary, each column shows how each ranking position is divided among the various alternatives (in absolute and relative terms).

Screenshot 21- Global Sensitivity Analysis: The summary.

5 Advanced settings

In this section, you can find support to understand the advanced functions of SOCRATES; in particular on quantitative variables to implement the Impact Matrix of the multi-criteria analysis, the Borda loser and the Sobol value in the Global Sensitivity Analysis.

5.1 The quantitative variables of the Multi-Criteria Analysis

In the section relating to the Impact Matrix (Step 3 of Multi-Criteria task), by clicking on the Manage button, you can access the **Advanced options** (Figure 7), where you can choose Quantitative or Qualitative variables. In the group of quantitative variables, you can select the most appropriate ***Score Type*** among those proposed: Numeric, Fuzzy, Stochastic, Numeric & Fuzzy (for more information see chapter 4.3.2. of Munda, 2008).

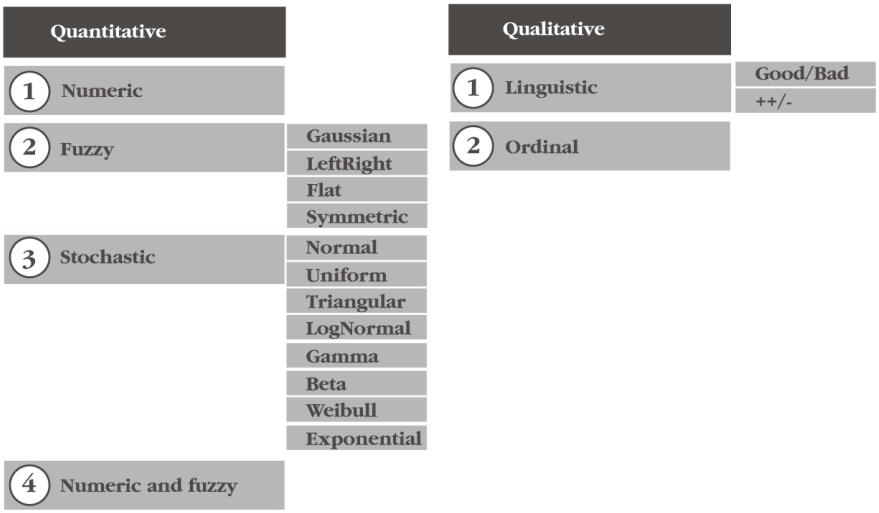


Figure 7 - Advanced options: Qualitative and quantitative variables of SOCRATES.

5.1.1 Quantitative score type: Numeric

You may assign a value in the form of a crisp number (*Numeric*) (e.g.: for the cost criterion a precise number expressed in currency unit), or give a quantitative definition affected by different levels and types of uncertainty.

5.1.2 Quantitative score type: Fuzzy

Here you can define the membership function of a fuzzy variable.

Depending on the selected *Score Type*, you can obtain a graph choosing among the associated functions proposed. Clicking on Manage and then on Advanced options it is possible to choose the name, the type of function between **Gaussian (i)**, **LeftRight (ii)**, **Flat (iii)**, and **Symmetric (iv)**.

i) Gaussian

Referring to the "Condominium problem" example, consider the performance of the "Garden" Alternative with respect to the "Extra-ordinary costs" Criterion. To streamline the process of implementation, all quantitative values corresponding to the performance of Alternatives according to the "Extra-ordinary costs" Criterion have been assumed as Numeric variables in the Impact Matrix. However, it is easy to understand that the values relating to "extra-ordinary costs" are not precisely quantifiable since it is difficult to estimate them exactly. Therefore, consider that this criterion belongs to the fuzzy category encoding imprecision and uncertainty.

The first fuzzy number you can use is the **Gaussian** curve (Screenshot 22). To obtain the corresponding graph, you have to enter the values of the parameters "m" and "k". Keeping the "m" value constant, as "k" increases the curve becomes closer to "m". Assuming m=800 corresponding to the value used in the Impact Matrix of the "Condominium problem" example, to quantify "Extra-ordinary costs" related to "Garden" Alternative, the Gaussian curve shown in Screenshot 22 can be obtained.

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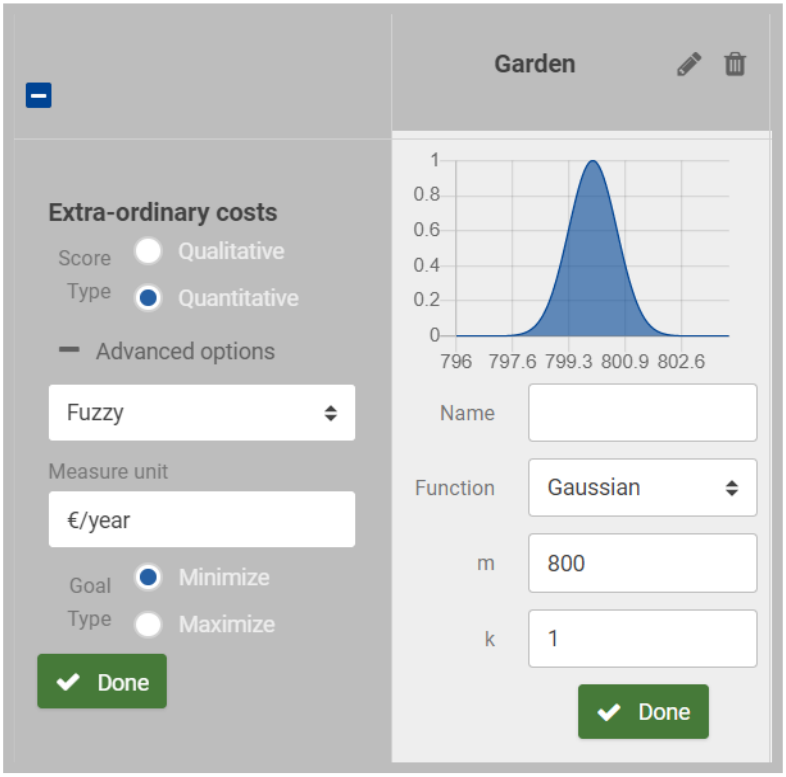


Screenshot 22 - Parameter setting for fuzzy function in the case of Gaussian quantitative variables.

ii) LeftRight

You can enter and manage three parameters to display the graph of the **LeftRight** fuzzy number (Screenshot 23):

"l" - the *left extreme* of the range;

"u" - the *right extreme* of the range;

"m" - the *modal value*.

Screenshot 23 - The parameters setting for fuzzy function in the case of LeftRight quantitative variables.

The "m" parameter can vary from the value immediately higher and closer to the extreme left (minimum) to the value immediately lower and closer to the extreme right (maximum) by changing the interval value in which the fuzzy membership is equal to 1, i.e. maximum membership.

Regarding the "Condominium problem" example, let's assume to ignore the exact (crisp) maintenance cost for the winner alternative "Vegetable Garden and Orchard". The Condominium administrator provides the co-owners with some budget estimation from third party companies. The eligible maintenance costs are not very precise since the design of the alternative is ongoing. The costs (€/year) vary in three ranges related to the preliminary estimation provided by the companies:

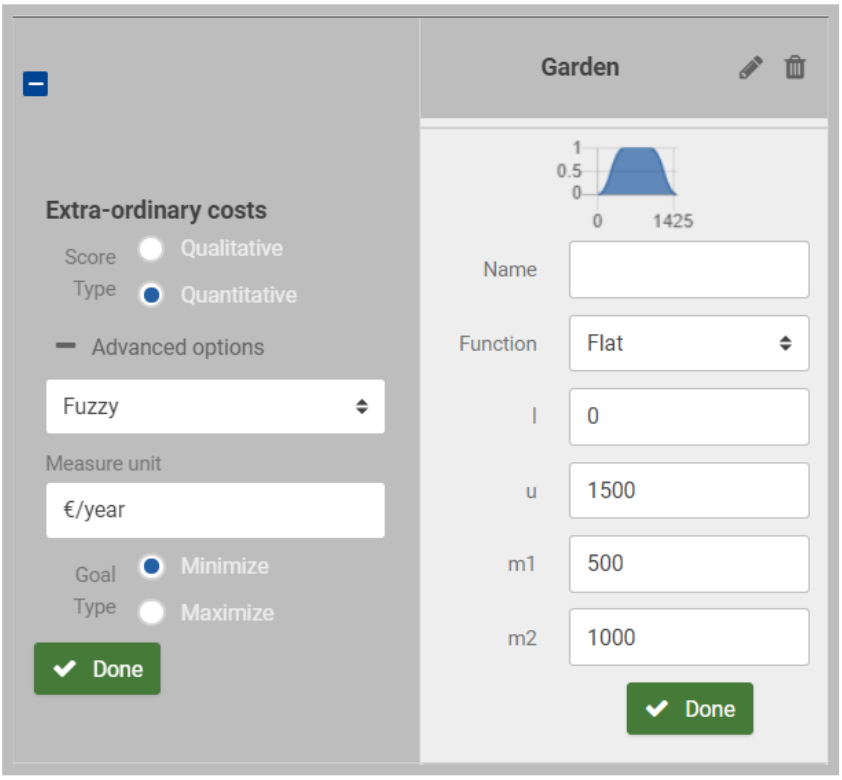
- The first interval of costs: from 3650 to 4000, including brushwood removal and vegetable garden fertilisation;
- The second interval of costs: from 3700 to 4200, including brushwood removal, fertilisation, cleaning, and gardener (once a month for six months);
- The third interval of costs: from 3800 to 4300, including brushwood removal, fertilisation, cleaning, and gardener (once a month for eight months).

From these ranges, you must first select the *left extreme* (minimum) equal to 3650 and the *right extreme* (maximum) equal to 4300. Then you can enter these values in Socrates and appreciate the variation of the fuzzy function graph when you change the *modal value* "m".

iii) Flat

Consider that you want to calculate the "Extra-ordinary costs" for "Garden" Alternative. For this purpose, you can choose the **Flat** fuzzy number illustrating the most credible numerical interval within which to identify the "Extra-ordinary Cost" relating to the "Garden" Alternative (Screenshot 24).

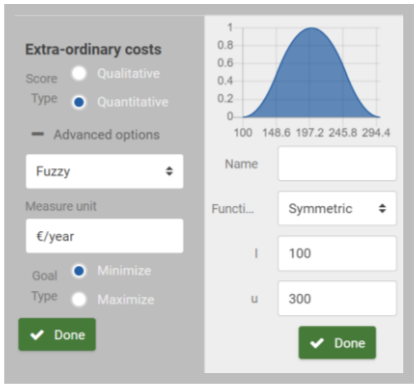
To obtain the graph of the Flat function, you have to enter first the values of the parameters "l" and "u" respectively corresponding to the lower and upper extremes of the domain of the function, and then "m1" and "m2" representing the extremes of the interval in which the value of the membership function is 1. Assuming "l"= 0, "u"=1500, "m1"= 500 and "m2"= 1000, the Flat curve shown in Screenshot 24 is obtained.



Screenshot 24 - The parameters setting for fuzzy function in the case of Flat quantitative variables.

iv) Symmetric

The **Symmetric** fuzzy function is similar to the Gaussian except that you need to enter the extreme parameters "l" and "u", corresponding to the range of extreme values in the function domain with "l" being the lower extreme and "u" being the highest extreme of the function domain (Screenshot 25). Assuming uncertainty related to the extraordinary costs (€/year) of the Paved Area in the "Condominium problem" example, a cost range from 100 to 300 may occur. The Symmetric curve shown in Screenshot 25 is obtained by inserting these parameters.



Screenshot 25 - The parameters setting for fuzzy function in the case of Symmetric quantitative variables.

5.1.3 Quantitative score type: Stochastic

In the case of Stochastic uncertainty, you have to choose the probability density function among Normal, Uniform, Triangular, LogNormal, Gamma, Beta, Weibull, Exponential functions (see Screenshots 26 and 27 where you can find examples referring to the Condominium problem).

1. Normal Distribution

This distribution is the most important probability distribution in statistics because it describes many natural and social phenomena. The shape of this distribution is defined by two parameters:

Mean μ, and

Standard Deviation σ.

These two parameters correspond to the maximum and width of the curve.

2. Continuous uniform distribution

The uniform distribution is concerned with events that are equally likely to occur inside a range whose bounds are defined by the two parameters, a and b ($a \leq b$).

3. Triangular Distribution

The shape of this distribution is a triangle defined by three parameters:

minimum value a,

maximum value b,

the most likely value (i.e. the peak value) c.

In many real-world situations one can often estimate these parameters.

4. LogNormal

The Lognormal distribution needs the definition of two parameters:

Mean μ, and

Standard Deviation σ.

This distribution can model various natural phenomena such as fatigue failure, failure rates, phenomena involving a large range of data the length of chess games and more.

5. Gamma

The Gamma distribution was introduced to predict waiting time, thus parameters defining it can only be positive ones. They are:

k called the shape parameter and

θ, the scale parameter.

It is very flexible and is used to model continuous variables that are not symmetric.

6. Beta

The Beta distribution is defined on the interval [0, 1] and require two positive parameters alpha (α) and beta (β) that define its shape. Like the Gamma distribution is very flexible, for example in Screenshot 27, there is a special case of Beta distribution with $\alpha=\beta=1$. In this case the uniform distribution with a=0 and b=1 is obtained.

The Beta distribution is widely used in many different contexts, from modelling the access to internet pages to the wavelet analysis.

7. Weibull

This distribution named after its inventor, require two positive parameters:

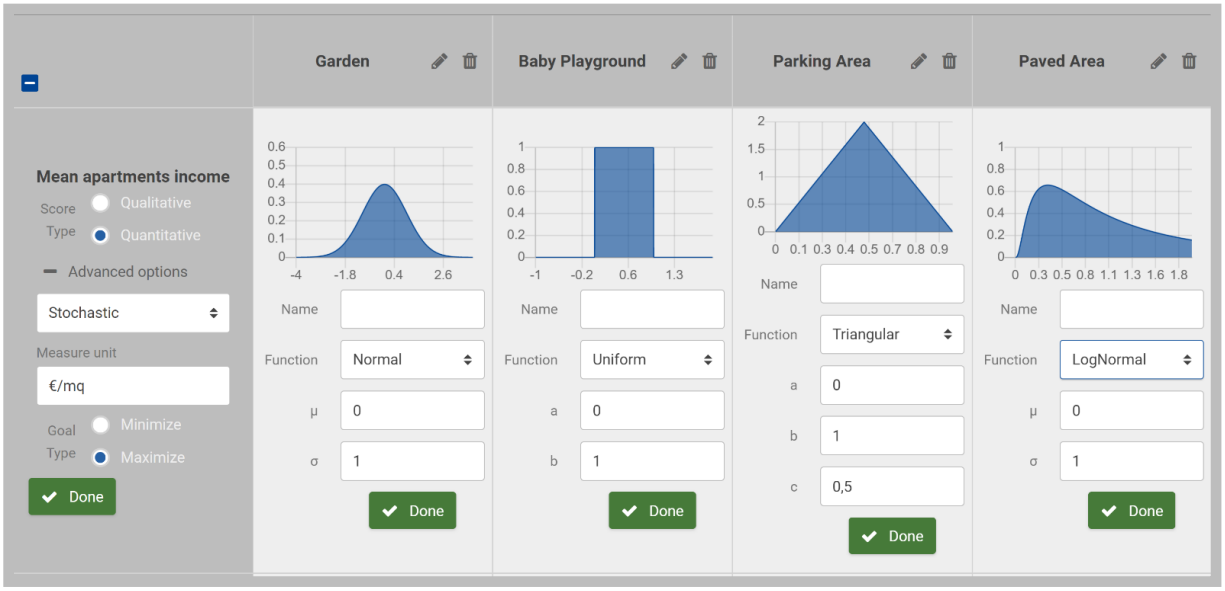
λ called the scale parameter, and

k, the shape parameter.

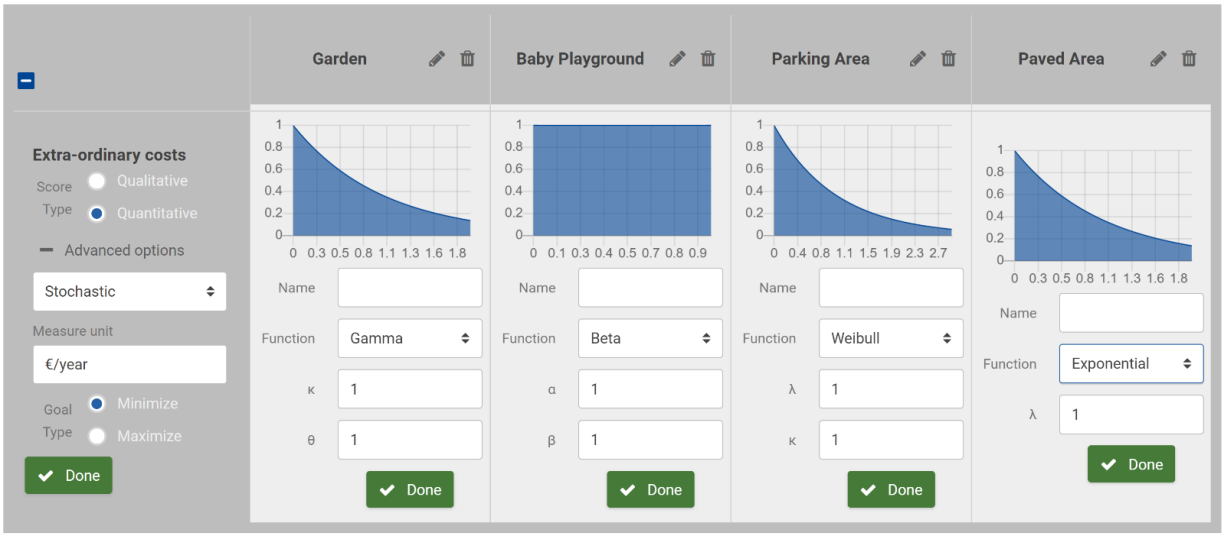
This distribution is very versatile and is widely used in many scientific contexts.

8. Exponential

The exponential distribution is special case of the gamma distribution. It requires a positive parameter λ, often called the rate parameter. It is often used to measure the expected time for an event to occur.



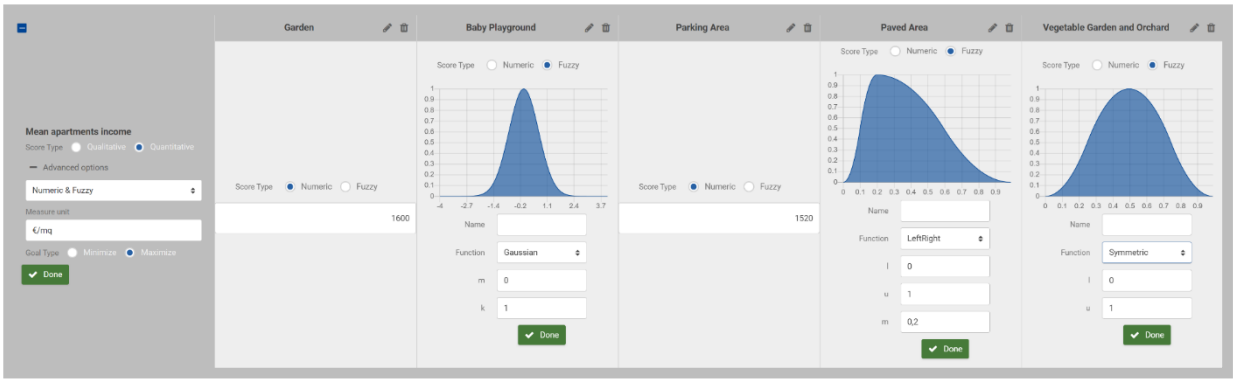
Screenshot 26- Examples of Stochastic functions Normal, Uniform, Triangular, LogNormal.



Screenshot 27*:* Examples of Stochastic functions Gamma, Beta, Weibull, Exponential.

5.1.4 Quantitative score type: Numeric and fuzzy

When defining criterion scores, you can also use the **Numeric and Fuzzy** function. It allows you to get Numeric scores and Fuzzy scores on the same criterion simultaneously. In the case of the Condominium you can appreciate this function for the "mean apartment income" criterion, whose values are shown as Numeric for the Garden and the Parking Areas, and Fuzzy for the Baby Playground, the Paved Area and the Vegetable Garden and Orchard (Screenshot 28).



Screenshot 28 - Numeric and Fuzzy function.

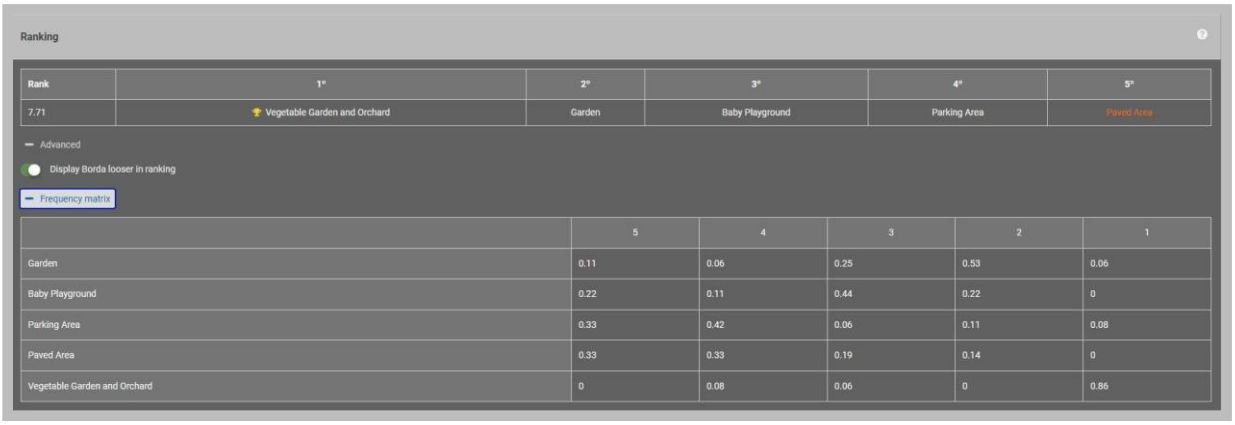
5.2 Borda loser and frequency matrix

In the Ranking step of the Multi-Criteria Analysis you can display the Borda loser alternative and the reverse ranking in the drop down menu of the Frequency matrix.

The **Borda loser** button changes the colour of the loser alternative in this step (Screenshot 29) and in the steps of the Sensitivity Analysis.

Screenshot 29 - Numeric and Fuzzy function.

In the Frequency matrix you can observe the reversed ranking in terms of the number of times each alternative is placed at each ranking position starting from the last position (Screenshot 30).



Screenshot 30 - Multi-Criteria Analysis. Step 6: Frequency Matrix from Borda count.

5.3 The Sobol value

Global sensitivity analysis focuses on all the possible combinations of criterion weights; all weights are changed simultaneously and with no constraint, i.e. extreme situations such as one criterion receiving 100% of importance are considered. The whole information produced is synthesised into simple graphics.

In this framework, Sobol' numbers are used to generate a representative sample of the total criterion weighting space. As a starting point, SOCRATES generates 1500 Sobol' numbers (called Sobol value); this is the number of simulations performed by SOCRATES to check the stability of the original ranking.

The Sobol value can be increased for more accurate results, but it's recommended to accurately manage it according to the computational machine power. One has to note that indeed the improvement in accuracy is very low, when Sobol value is set bigger than 1500.

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Saltelli A, Annoni P, Azzini I, Campolongo F, Ratto M, Tarantola S. (2010) *Variance based sensitivity analysis of model output. Design and estimator for the total sensitivity index*. Computer Physics Communications, 181 (2), 259-270, doi:10.1016/j.cpc.2009.09.018

List of abbreviations and definitions

GUI	Graphical User Interface
IA	Impact Assessment
MCDA	Multi-Criteria Decision Analysis
SMCE	Social Multi-Criteria Evaluation
SOCRATES	**SO**cial multi-**CR**iteria **A**ssessmen**T** of **E**uropean policie**S**

List of boxes

List of figures

List of screenshots

Appendix

How to start and manage a project

Home

It takes you to the home screen

Start

It allows you starting a new project

Info

It provides you with information **About** SOCRATES and an email address for **Contact**

Load a datafile

Edit a datafile

Save a datafile

New project

Create a new project from scratch

Import / Restore

Load an existing project or restore a backup

Duplicate

Create a copy of your project

Rename

Change the name of your project

Export

Export your project in json format

Backup projects

Download a backup for all your projects in json format

Delete

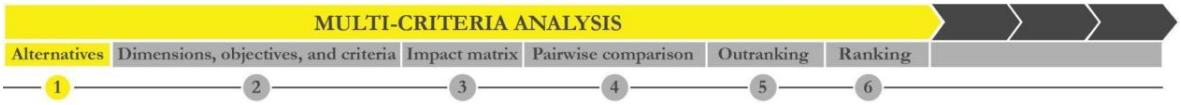
Delete all data in your project

Save on this browser

The project is saved in your browser IndexedDB

Save and export

The project is saved in your browser IndexedDB and you must Download export file from the link that appears under the **Save** button



Add Alternatives

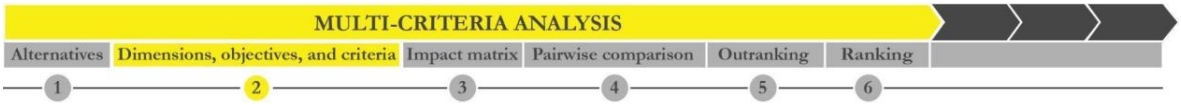
This button allows you to create a new alternative

Manage Alternatives

This button allows you to edit the name of the alternative and add a brief description

Delete Alternatives

This button allows you to delete an alternative



Add Dimension

This button allows you to create new Dimensions

Add Dimension

This button allows you to create new Dimensions using the pie chart graph

Add Objective/Add Criterion

This button allows you creating new items in the lower category in terms of Objectives (if you click on Add objective) and Criteria (if you click on Add criterion)

Manage

This button allows you to change the name of the category and add a brief description.

Weight

You can set the Weight of an item using this scrollbar.

Move

This button allows you changing the order of items

Delete

This button allows you to delete an item (dimension, objective, criterion)

Dimensions

This button allows you assigning the same weight to all Dimensions

Criteria

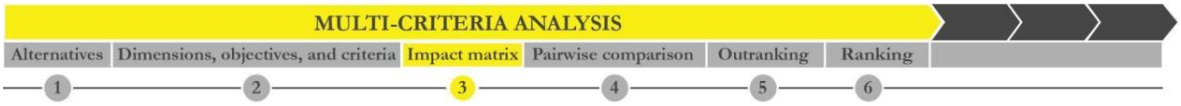
This button allows you assigning the same weight to all Criteria

Zoom In

Clicking on the area related to a specific category within the pie chart you can visualise the specific branch of decision-problem and the hierarchical levels subordinated to it

Zoom Out

Clicking on Back you return to the pie chart original view



Add Alternatives (in addition to those created in the Step 1)

Manage Alternatives

This button allows you to change the name of Alternatives and add a brief description

Delete

This button allows you to delete Alternatives

Manage Criteria

This button allows you to enter in a drop down menu where you can:

Set the *Score Type* (**Quantitative**, **Qualitative**),

Access to the *Advanced options*

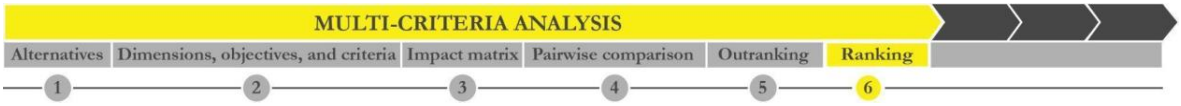
Select *Goal Type/Scale*

Thresholds

This button allows you to set the preference and indifference thresholds of criteria

Import

This button allows you to import the Impact Matrix as a csv file

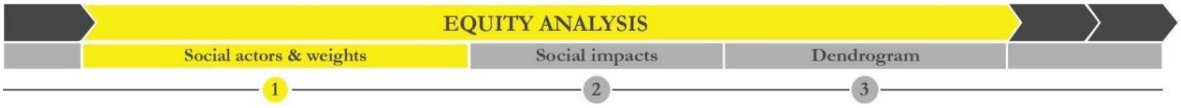


Visualise the final ranking

Open **Advanced options**

Display the Borda loser in ranking

Display the frequency matrix.



Add group

Add a group of social actors in the decision model

Groups

Assign the same weight to all groups

Weight

Change the weight of each group moving the scroll bar

Manage

Allow to enter name and description of a group

Delete

Delete a group

Add alternative

Insert new alternatives in the decision problem

Manage Groups

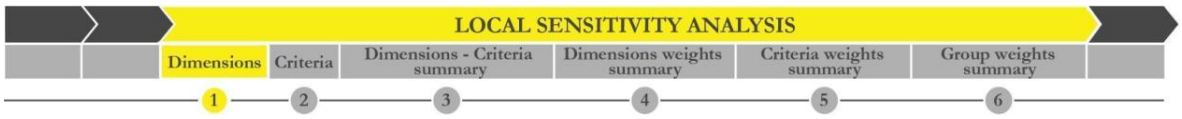
Enter the name and description, and set an evaluation scale for a group

Manage Alternatives

Enter the name and description of an alternative

Delete

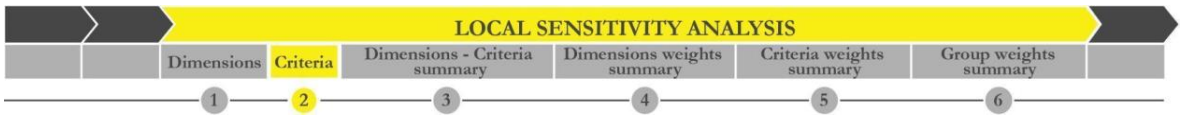
Delete groups or alternatives



Visualise the original ranking and the local rankings per each dimension

Identify the winner alternative

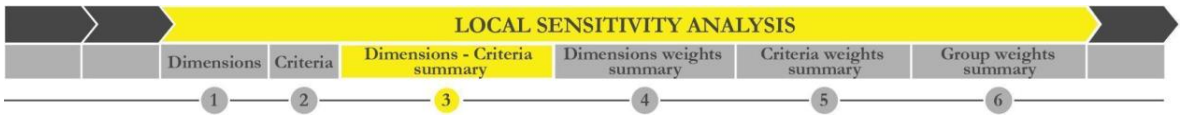
Identify the winner alternative for that specific ranking



Visualise the original ranking and the local rankings excluding criteria one by one

Identify the winner alternative

Identify the winner alternative for that specific ranking



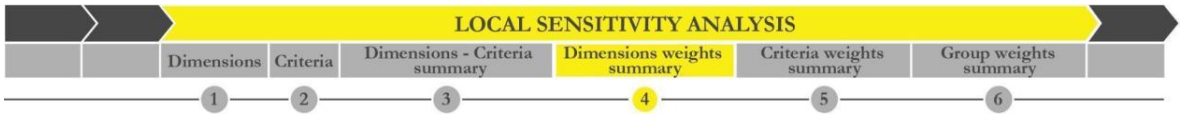
Visualise the original ranking and the *Dimensions - Criteria summary* matrix

Identify the winner alternative

Visualise the normalised values of the matrix in pie charts

Visualise the absolute values of the matrix in bar charts

Scroll the cursor up the bar charts and pie charts to display how many times an alternative is placed in each ranking position



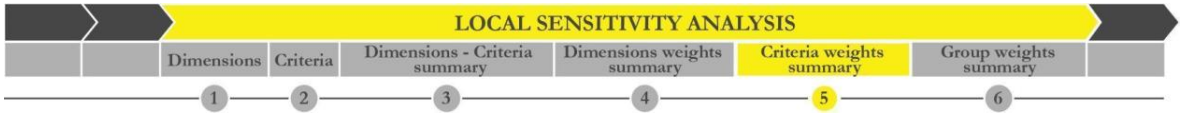
Visualise the original ranking and the *Dimensions weights summary*

Identify the winner alternative

Visualise the normalised values of the matrix in pie charts

Visualise the absolute values of the matrix in bar charts

Scroll the cursor up the bar charts and pie charts to display how many times an alternative is placed in each ranking position



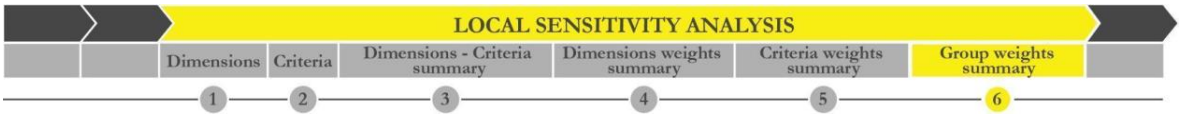
Visualise the final ranking and the *Criteria weights summary*

Identify the winner alternative

Visualise the normalised values of the matrix in pie charts

Visualise the absolute values of the matrix in bar charts

Scroll the cursor up the bar charts and pie charts to display how many times an alternative is placed in each ranking position



Visualise the final ranking and the *Group weights summary*

Identify the winner alternative

Visualise the normalised values of the matrix in pie charts

Visualise the absolute values of the matrix in bar charts

Scroll the cursor up the bar charts and pie charts to display how many times an alternative is placed in each ranking position

Visualise the original ranking and how many times an alternative goes in each ranking position

Visualise the normalised values of the matrix in pie charts

Visualise the absolute values of the matrix in bar charts

Advanced options

Change the Sobol value

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