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Evaluation Tool Manual

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Project full title: **New cooperative business models and guidance for sustainable city logistics**

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List of abbreviations

Abbreviation	Definition
ABM	Agent-Based Model
AHP	Analytic Hierarchy Process
D#.#	Deliverable number #.#
EU	European Union
GDP	Gross Domestic Product
IA	Impact Assessment
IAG	Impact Assessment Guidance
IAM	Impact Assessment Module
LCI	LifeCycle Index
LSI	Logistics Sustainability Index
RAM	Risk Analysis Module
SCBA	Social Cost-Benefit Analysis
SCBM	Social Cost Benefit Module
TAM	Transferability and Adaptability Module
TMC	The Transtheoretical Model of Change
UFT	Urban Freight Transport
WP	Work package

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1. Introduction

1.1. What is the Evaluation Tool

The Evaluation Tool is a web-based platform, which is composed of several components, and aims to provide to the user the desired information for assessing measures through a before and after analysis. When using the Tool, the city is the starting entity, and each stakeholder category completes all succeeding steps based on its interests and objectives. In this case, results reflect the specific stakeholder category. The Evaluation Tool enables comparing simultaneously among different categories, thus it provides an open platform for discussion and exchange. If weights are attributed to all involved and relevant stakeholder categories, an overall assessment reflects the city, as one entity.

In the Evaluation Tool, a set of parameters is available for selection by each stakeholder category, including impact areas, criteria, composite indicators and indicators. Based on the selected parameters, the evaluation process may generate multi stakeholder multi criteria evaluation results, as well as results processed separately, upon user request, by each of the embedded modules.

Apart from the multi stakeholder multi criteria evaluation, the Evaluation Tool user may select specific evaluation methodologies, out of the available embedded into the Tool, as modules. The structure of the Evaluation Tool involves four assessment methodological modules, namely Impact Assessment (IAM), Social Cost-Benefit (SCBM), Transferability and Adaptability (TAM) and Risk Analysis (RAM). Those tasks are further integrated through the Behavioral Modeling, which aims to support the four modules in the qualitative data collection, to formulate the measurement variables (questions and/or statements), to enable measuring the possibility of behavioral changes towards UFT measures capturing the involved stakeholders' approach and point of view, to support the training activities on NOVELOG tools and to structure the data analysis methodology.

The Evaluation Tool provides to the user the desired information for assessing current and future Urban Freight Transport - UFT (policies and) measures. The Tool enables comparing simultaneously among different stakeholder categories, facilitating the user to choose among indicators that are relevant to stakeholder categories and lifecycle stages. The selected weighing methodology adopts a pairwise hierarchical process (Saaty, 1980), allowing comparison between elements of the same level (impact areas, criteria and indicators). The embedded in the Tool normalization process estimates the sustainability performance of each alternative measure relative to the best performance encountered in the assessment. The Evaluation Tool aggregates selected components (i.e., indicators, criteria, impact areas, etc.) into indices to enable comparisons between measures for a before-after based scenario. For each measure, the Evaluation Tool generates five indices: 1) Index per impact area per lifecycle stage, 2) Index per impact area for the measure's lifecycle, 3) Index per lifecycle stage, 4) Logistics sustainability Index, and 5) Global Logistics Sustainability Index.

For determining behavior or behavioral changes towards the desired or expected direction Agent-Based models and the Transtheoretical Model of Change are being used for a quantitative and qualitative analysis of change. Finally, the Evaluation Tool user may select specific evaluation methodologies, which have been embedded in the Evaluation Tool as modules, including the Impact Assessment (IAM), the Social Cost-Benefit analysis (SCBM), the Transferability and

Adaptability (TAM), and the Risk Analysis (RAM). When selected, the modules retrieve all necessary information from the main data entry platform (Evaluation Tool), and prompt the user to enter any additional data, when necessary. Each module processes data individually for estimating the desired outcome, which may supplement the five indices, above. The Evaluation Tool assists decision makers in transportation planning to show potential tradeoffs among selected sustainability impact areas, lifecycle stages, stakeholder categories and module outcomes for different choices of UFT measures.

The Evaluation Tool has been initially designed to be used by the NOVELOG cities for the assessment of the performance and efficiency of the innovative policies and measures adopted and applied to each one of them. However, it is designed and structured in such a way in order to be feasible and flexible to be used by the NOVELOG network cities and any other city as well for the assessment of current policies and measures in the domain of city logistics. So, it constitutes a supportive decision making tool which may be used by decision makers to come up with the best or optimum choice and transport planners to: 1) Support, justify and validate decisions, policies and measures taken and applied at tactical and operational level, 2) Rank future alternative solutions or scenarios pertaining to the last mile goods distribution, the supply chain and logistics' planning and designing process at strategic level. Using the Evaluation Tool, the involved stakeholders may support future decisions for strategic planning purposes, addressed by various criteria, trends and trade-offs.

1.2. Evaluation Tool Overview

The framework involves four assessment methodological modules, namely Impact Assessment (IAM), Social Cost-Benefit (SCBM), Transferability and Adaptability (TAM), and Risk Analysis (RAM), while Behavioral Modeling (BM) is also integrated in order to support the modules in the qualitative data collection, as well as to enable measuring the potentiality of behavioral changes towards the proposed measures on achieving sustainability in cities. The brief description of the modules and their functionalities are provided below:

1. Impact Assessment Module (IAM) offers two main options depending on whether the user has access to one of the available models (i.e. software packages/platforms) for estimating impacts or not. Depending on the user's competence and experience, simple, moderate and sophisticated methodologies are provided, along with references for further information acquisition by the user.

2. Social Cost Benefit Analysis Module (SCBM) assesses the planned and/or implemented solution(s) expressed in monetary terms. The SCBM estimates societal and financial impacts in monetary terms. The methodology that is followed in the SCBM estimates congestion, air pollution, climate change, accidents, noise and employment and development.

3. Transferability and Adaptability Module (TAM) facilitates identifying how feasible if is for a city to develop completely a new measure from scratch, to directly implement practically proven measures from another city and to adopt practically proven solutions while making changes that mainly depend on the implementation environment. An Adaptability Diagram shows to which extent the given measure fulfils the assumed critical success factors, and computes the success indicator which depicts the degree of fulfilment.

4. Risk Analysis Module (RAM) assesses external risks, such as socio-political, economics, availability of infrastructure and technology innovations and natural disasters and civil disturbances, and internal sources of risk include management, human resources, marketing, information technology (IT) and financial.

The Behavioral Modeling (BM) with use of agent-based models (ABMs) is addressed to all stakeholders that interact with urban environment and are responsible for impact generation. This is achieved through the conduct of respective questionnaire surveys based on stated and revealed preferences methods aiming at the identification of attitudes, habits, and norms of the city logistics operators and investigation of the possibility of behavioural changes.

The functions of the evaluation, following the concept of multi-stakeholder multi-criteria assessment methodologies, are depicted in Figure 1.1.

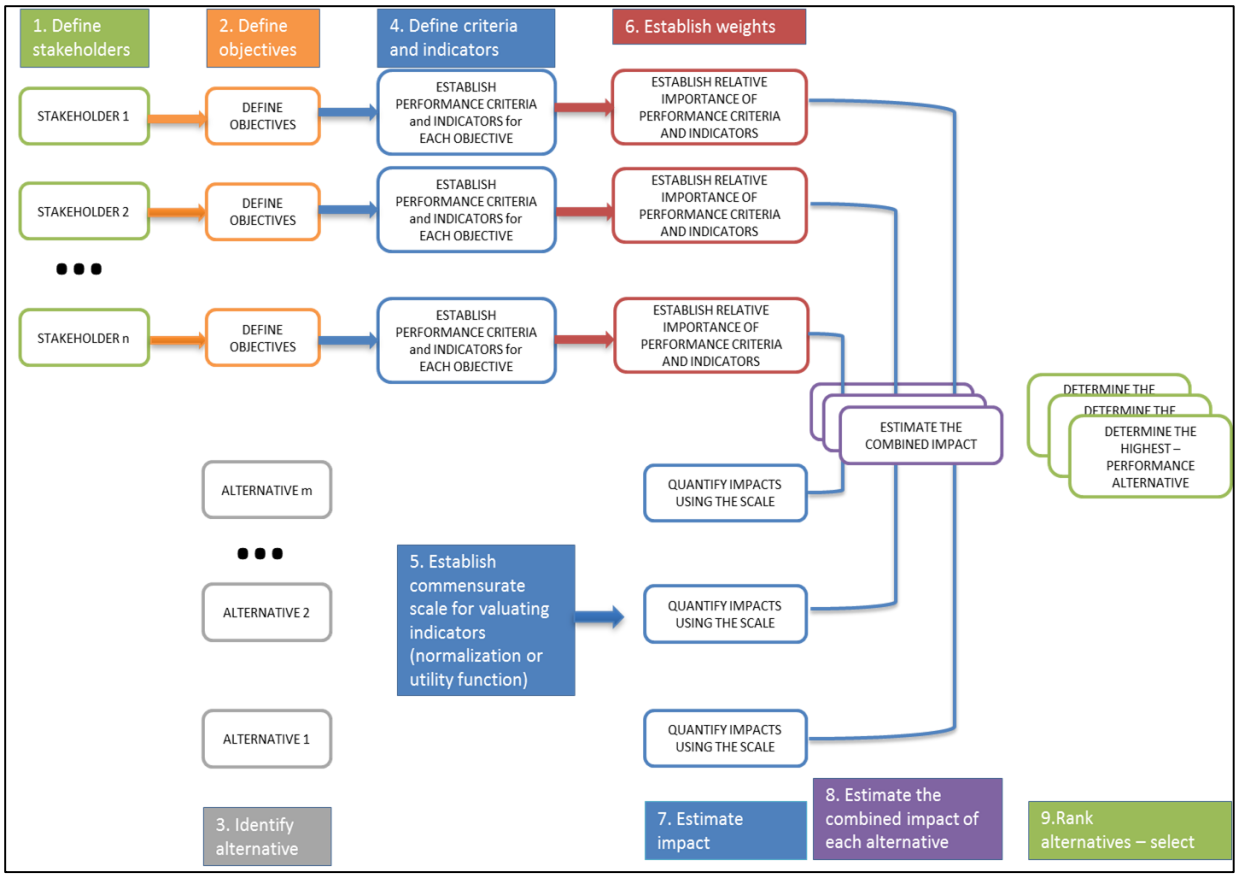


Figure 1.1 Structure and functions of the Evaluation Tool

The first function (function 1) includes the definition of the involved stakeholders, while the determination of specific objectives per stakeholder category is part of function 2. In parallel, alternatives in terms of different scenarios modeling each situation are built (function 3). Each scenario is tested against a number of representative performance criteria and respective indicators, which are established and associated with the stakeholders' objectives (function 4). A commensurate scale is developed for the evaluation of the indicators through normalization or utility function (function 5). In parallel, weights per impact area, criterion and indicator are estimated, (function 6) and in combination with the values of the indicators, the estimation of

impacts is feasible (function 7). In function 8, the combined impact of each alternative is estimated, and ranking of alternatives and selection follows (function 9). It should be highlighted that the tool enables the incorporation of lifecycle inventory in the respective functions, where appropriate, so that each combination of the above input data is mapped from creation, through operation and maintenance to closure.

The Evaluation Tool is composed of several components, as depicted within Figure 1.2 and aims to provide to the user the desired information for assessing measures through a before - after analysis. When using the tool, the city is the starting entity and each stakeholder category completes all succeeding steps based on its interests and objectives. In this case, results reflect the specific stakeholder category.

The Evaluation Tool enables comparing simultaneously among different categories, thus it provides an open platform for discussion and exchange. If weights are attributed to all involved and relevant stakeholder categories, an overall assessment reflects the city, as one entity. Weights are given by experts, following a Delphi method, when a 70% consensus is achieved.

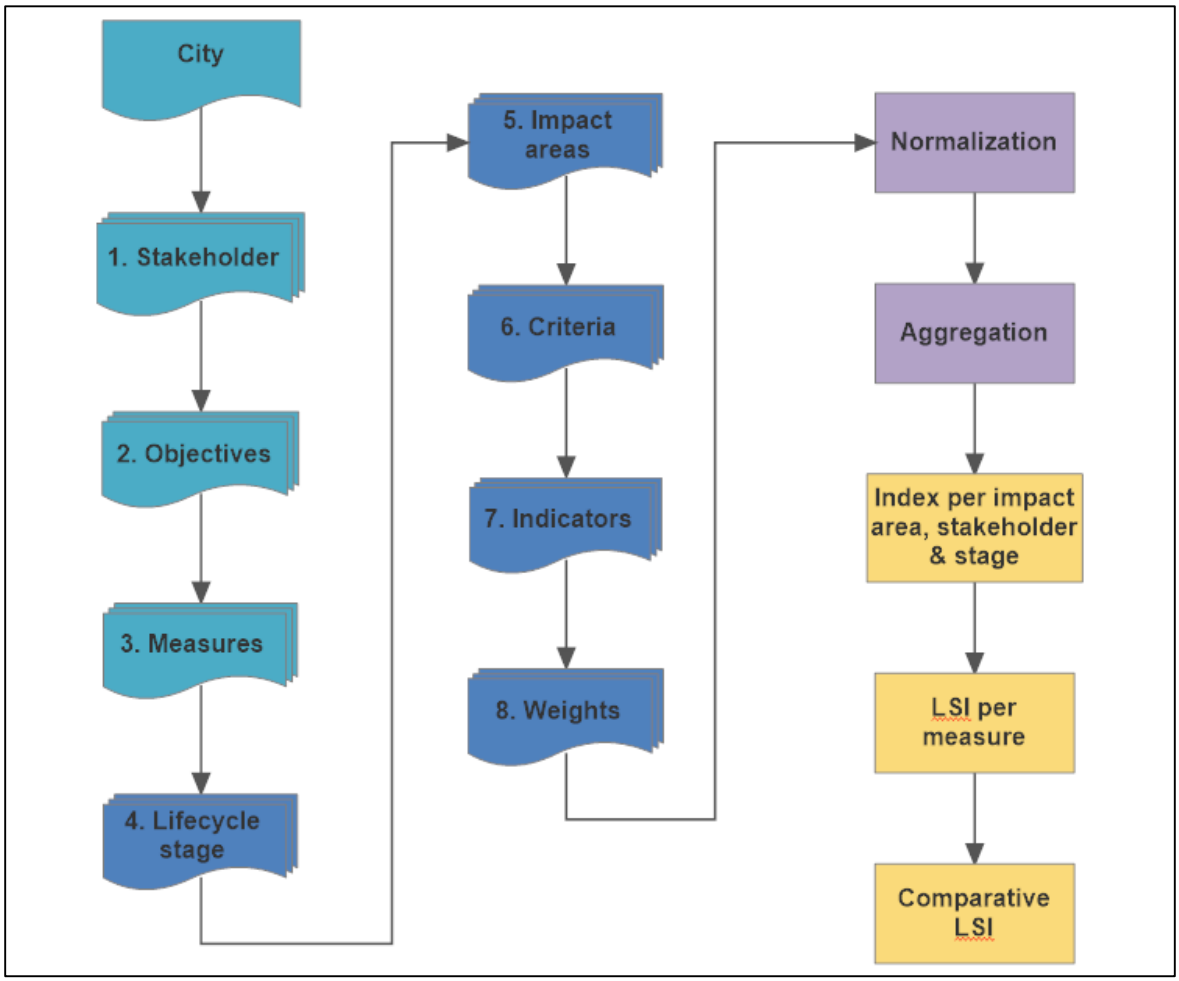


Figure 1.2 Evaluation Tool functionality flow diagram

Any entity that uses the tool is referred to as “user” in the implementation steps described below briefly, meaning user of the tool, thus it should not be confused with the term stakeholder:

- **Step 1.**The user identifies the stakeholder category he/she represents, from a provided list.
- **Step 2.** The user states one or more objectives that he/she is interested in the implementation of a UFT measure in the city. The tool embeds objectives revealed by the NOVELOG cities. However, new objectives can be entered by the user.
- **Step 3.**The framework enables choice of a set of available measures, as defined in NOVELOG. For the NOVELOG cities, the association of the city to the measures is predetermined. However, the user may select and deselect measures. He/she can also enter a new measure to the database. Only one measure may be assessed at a time.
- **Step 4.** The user is prompt to select at least one of the four lifecycle stages for which the evaluation is going to be performed. An association of the measures with the lifecycles is pre-set in the tool for the available measures. A description of the processes taking place within each stage is also provided to facilitate the user. All stages are available to the user for a newly-entered measure.
- **Step 5.** The user selects at least one of the seven impact areas for which the assessment of the measure will be performed. The association of the impact areas, measures and stages is predetermined in the framework for the available measures. All areas are available to the user for a newly-entered measure.
- **Step 6.** The criteria that are linked to the selections of step 4 (lifecycle stages) and 5 (impact areas) are listed in this step. The user may select all suggested by the tool criteria, or deselect some of them. All criteria are available to the user for a newly-entered measure.
- **Step 7.** In this step, the user selects the final indicators from the indicator list, which is provided for each criterion (and impact areas), measure and lifecycle stage. The user may deselect indicators from the suggested list. All indicators are available to the user for a newly-entered measure. Values (quantitative or qualitative) are entered by the user for the selected indicators. In the case of some indicators that are composed by more variables, so-called basic indicators, the user is asked to provide values for the basic indicators.
- **Step 8.** The user incorporates his/her preferences and priorities, by assigning weights to impact areas, criteria and indicators, following a menu-driven process.

When a new measure is entered, all relevant information should be defined by the user. Inclusion of an indicator to the appropriate lifecycle stage and impact area is a sensitive task and requires experienced user. A detailed description of these steps is outlined in Chapter 4.

The next actions of the procedure that are shown in purple and yellow boxes in Figure 1.2 consist background processes of the evaluation tool and occur “automatically”, without the intervention of the user. Finally, indices per measure and impact area are aggregated into a Logistics Sustainability Index (LSI) per measure that is used for the comparison of the sustainability performance between measures or for the evaluation of the same measure in different scenarios (before after evaluation) as these are defined by the user (NOVELOG, 2016d)

2. Terminology

This is an alphabetical list of the main terms used in this document to facilitate utilization of and guide the user through the Evaluation Tool.

The Evaluation Tool consists of several components that enable its successful implementation for the assessment of logistic measures by taking into account city characteristics and stakeholder groups. In brief, the basic components and their interrelations are briefly depicted below:

- **Cities**: NOVELOG incorporates the analysis of a total of twelve city cases: six pilot cities (Athens, Turin, Barcelona, Rome, Graz and Mechelen) and six case studies (London, Emilia Romagna Region, Copenhagen, Venice, Gothenburg and Pisa), where a number of twenty two (22) UFT measures are monitored, tested and evaluated as per their deployment, adaptability, operation and effectiveness in the respective urban context.
- **City case: Pilot / Case study**: Experimental research testing of the application of a set of UFT measures in a given urban context (usually a city or a wider metropolitan area or a region), called the area of study. It has a predetermined duration, structure and involved stakeholders with their roles, operations, activities and tasks fully allocated amongst each other. It is usually deployed in order to investigate the feasibility of the tested concept, to identify possible gaps and potential inefficiencies, to enrich the data base through data collection on the selected concept, to evaluate the operability of systems involved and to test the efficiency, applicability, transferability and take up of the selected UFT measures in other different urban contexts even beyond project duration.
- **Composite indicator**: The grouping of a set of (basic) indicators. The composite indicator represents the meaning, functionality, importance and attributes of all the incorporated (basic) indicators in a more generic way.
- **Compound indicator**: The indicator that is used by modules to provide a complex measurement to the user. A compound indicator is the combination (i.e., multiplication, division, etc.) of an indicator (data that were inserted in the Evaluation Tool) and data that are inserted in the module and/or data that are incorporated in the module by default.
- **Criterion / Criteria**: The standard(s) by which something can be judged or decided. In a typical context, there is more than one criterion under consideration and thus the plural 'criteria' is more commonly encountered. Evaluation Tool incorporates a total of 26 criteria, 22 composite indicators and 140 indicators scattered within 7 impact areas.
- **Evaluation**: Systematic determination of a measure's performance, merit, worth and significance, using criteria governed by a set of standards.
- **Evaluation parameters**: In the Evaluation Tool, a set of parameters is available for selection by each stakeholder category, including impact areas, criteria, composite indicators and indicators. Based on the selected parameters, the evaluation process may generate multi stakeholder multi criteria evaluation results, as well as results processed separately, upon user request, by each of the embedded modules.
- **Impact area**: There are seven impact areas defined in the Evaluation Tool. The impact areas consist of four sustainability disciplines (Economy and energy, Environment, Transport and Mobility, Society) and three applicability enablers (Policy and measure maturity, Social acceptance, User uptake).
- **Index**: An index is an indicator or measure of something, typically referring to a statistical measure of change. Statistical device which summarizes a collection of data (usually related to the price or quantity of a 'basket' of goods and services) in a single base figure. This

composite figure serves as a benchmark for measuring changes in the price or quantity data over a period (month, quarter, and year). Usually, the base is assigned an arbitrary value of 100 and all subsequent data is expressed in relation to this base.

- **Indicator**: Categorized into quantitative or qualitative and constitute statistics and standards used to measure or represent current conditions as well as to forecast financial or economic trends. Economic indicators are statistical metrics used to measure the growth or contraction of the economy as a whole or sectors within the economy. Technical indicators are any class of metrics whose value is derived from generic price activity in a stock or asset and are used extensively in technical analysis to predict changes in stock trends or price patterns in any traded asset.
- **Lifecycle stage**: Four distinct stages of lifecycle are determined for each selected measure. These are: 1) Creation – construction, 2) Operation, 3) Maintenance, and 4) Closure – disposal.
- **Measures**: NOVELOG has come up with a list of 22 UFT measures, which are distinguished into two main categories, the mega-concepts, which are “Cooperative logistics” and “Administrative and regulatory schemes and incentives”.
- **Modules.** Each module is associated to a set of indicators and takes them into account for the estimation of the module specific outcomes.
- **Objectives**: The objective goals set by each city in order to reach a higher level in last mile distribution operational activities and respective provided services. These are distinguished in primary (e.g. economic, environmental etc) and secondary (e.g. business models, use of new, advanced technologies etc.).
- **Run**: An iteration of an iterative process, when the Evaluation Process of the alternative solutions based on scenario building is in progress.
- **Scenario**: The full and integrated description of a situation or alternative solutions (current or future) in the urban environment, providing data on supply / demand side and respective characteristics on transport, mobility, infrastructure and equipment, attributes, and socioeconomic facts and figures.
- **Stakeholders**: NOVELOG, based on literature review and in order to simplify the several categories of stakeholders involved in UFT operations and activities, has concluded to three main categories of stakeholders, namely: supply chain stakeholders (including supply and demand side, in particular Freight Forwarders, Transport Operators, Shippers, Major Retail chains, Shop owners), public authorities (incorporating Local Government, Regional authorities and National Government) and other stakeholders (i.e. General public, Industry and Commerce Associations, Consumer Associations, Research and Academia).
- **UFT activity**: Any activity associated with or incorporated into the supply chain, including pick up, delivery, transport, loading / unloading, transshipment, monitoring, containerization / palletization, handling of cargo, etc.
- **Weight**: Significance of an impact area, a criterion or (composite) an indicator within the whole (multi stakeholder multi criteria) evaluation process. The significance / weight is estimated based on experts opinion (e.g. DELPHI method) and / or taking into account each involved stakeholders’ approach and point of view following the pairwise comparison of criteria and indicators with each other and the Analytic Hierarchy Process (AHP) methods.

3. Getting Started

3.1. System Requirements

The software tool integrates web technologies (web services, n-tier architecture, client and server side programming, information services and a complex forecasting algorithm for division of measures, criteria and several assessment mechanisms for the calculation of LCI's and LSI's) into a single web-based application that is user friendly and has the ability to manage and depict all necessary functionalities.

The system is developed ASP.NET, HTML and in JavaScript programming language using the Microsoft's ASP.NET Framework 4. The development of most of the classes for the object oriented programming for the back-end of the system was done using the C# programming language.

The Evaluation Tool needs to be deployed on a Windows server machine, running IIS and MSSQL databases in order to be fully functional and available through internet. It runs on all major browser (i.e., chrome, Firefox, Explorer, etc.) with minimum requirements. It runs on any operating system including Windows XP, Vista, 7, 8 as well as Linux, mac etc.
There are no physical hardware minimum requirements for the users.

3.2. Access and Registration

The NOVELOG Evaluation Tool is available at: http://evalog.civ.uth.gr/

In order to access the NOVELOG Tool's Web Application the user should register first, by clicking on the 'Registration' tab at the home page (Figure 3.1). Having filled in the requested personal data information i.e. name, relevant city, stakeholder category, contact information, the credentials (username and password) will be sent to user's contact e-mail after being approved by the system administrator.

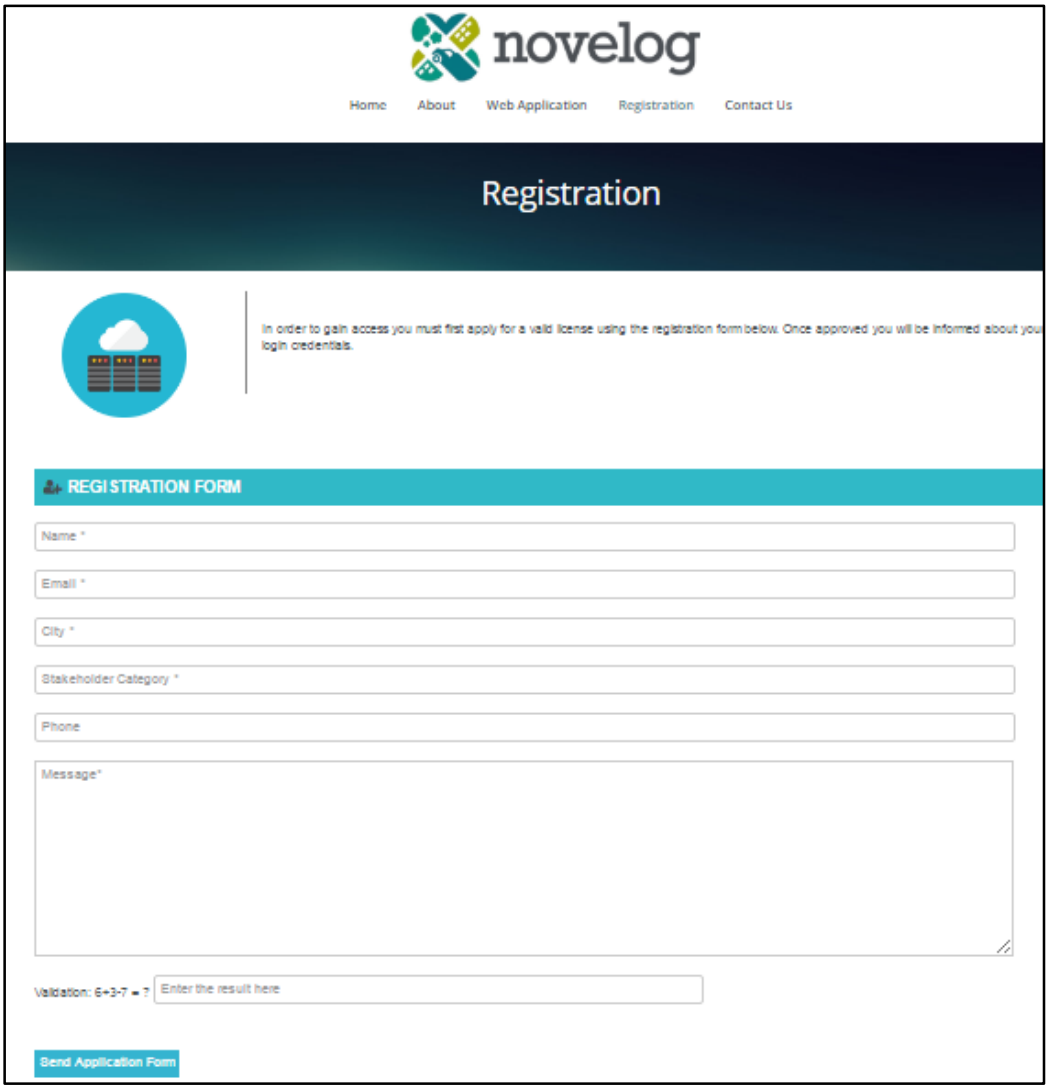


Figure 3.1 Registration form

As a next step the user should log in into the web application. To log in the user should click on the 'Web Application' tab at the home page and fill in the username name and password that were provided to him/her following the registration (Figure 3.2).

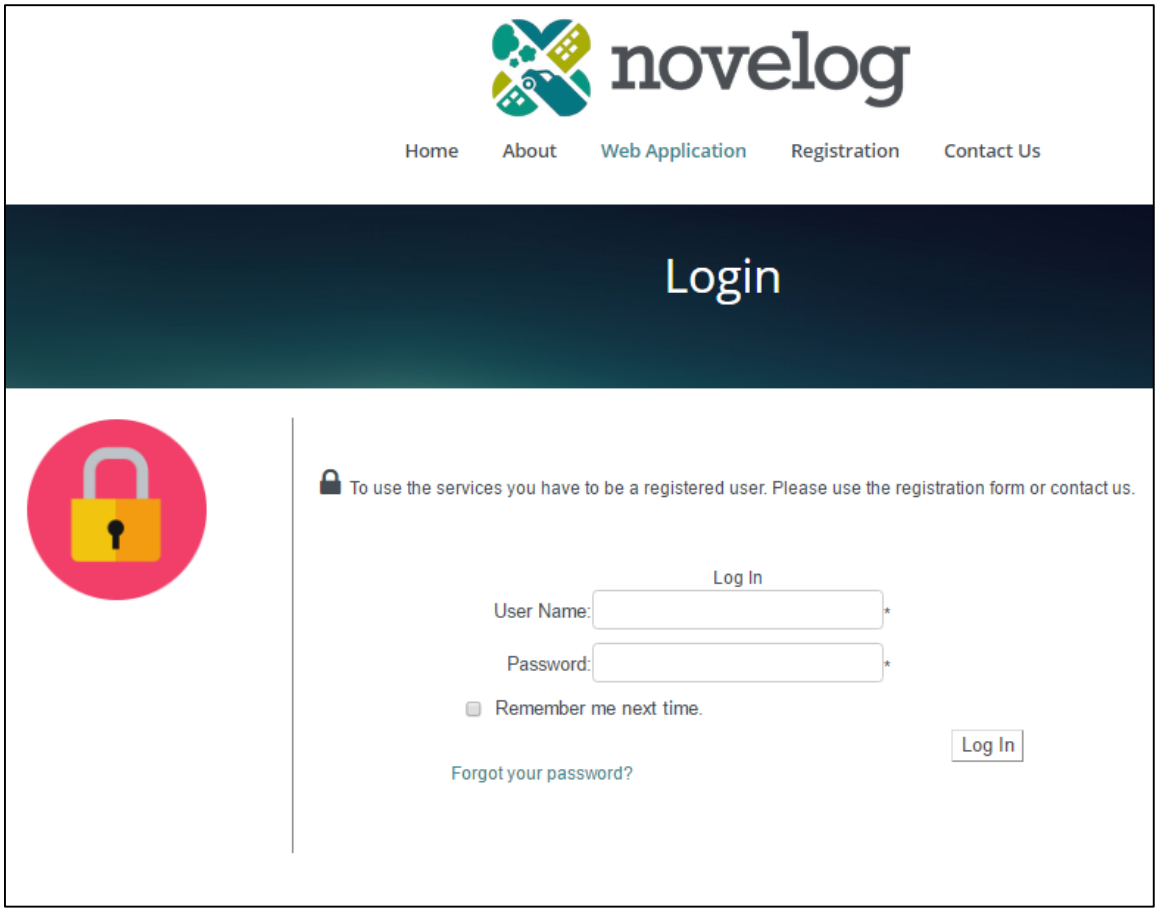


Figure 3.2 Log in into the web application

The initial automatically generated password can be changed by clicking 'Profile' at the main menu box (Figure 3.3).

Setting a new password: Setting a new password requires a minimum of 6 characters (letters, numbers, symbols or combination of all).

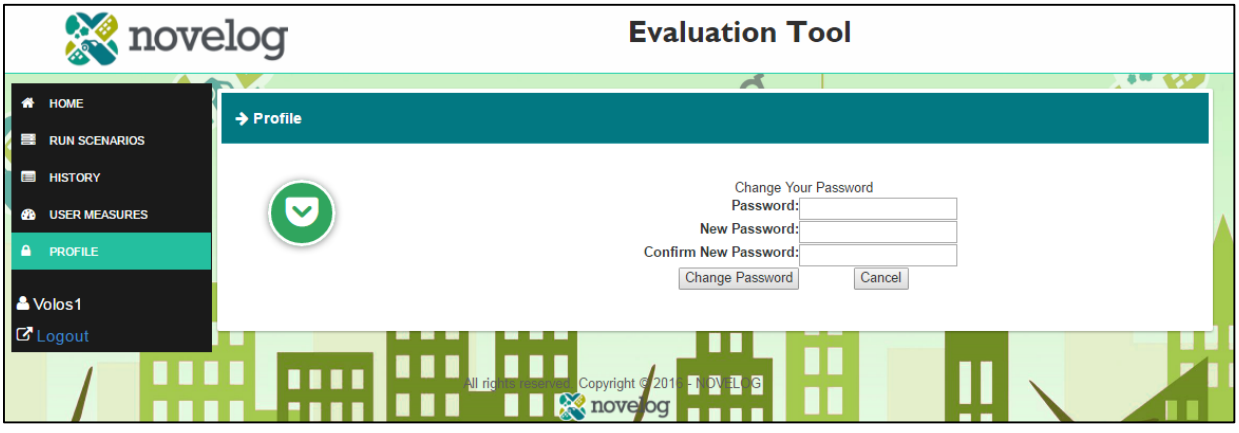


Figure 3.3 Change passwords

3.3. Getting Help

Further information and detailed descriptions for the Evaluation Tool and its components can be found in the following documents on the NOVELOG download page: http://novelog.eu/downloads/.

- NOVELOG's Deliverable 2.1. Framework for data, information and knowledge collection for urban freight and service demand understanding (NOVELOG, 2016a).
- NOVELOG's Deliverable 2.2. Urban freight and service transport in European cities (NOVELOG, 2016b).
- NOVELOG's Deliverable 2.3. "Understanding Cities" Tool (NOVELOG, 2016c).
- NOVELOG's Deliverable 3.1. Integrated assessment framework for UFT solutions (NOVELOG, 2016d).
- NOVELOG's Deliverable 3.2. Evaluation Tool (NOVELOG, 2016e).

Additional information can also be found in:

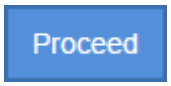
- NOVELOG official website: http://novelog.eu/
- NOVELOG facebook: https://www.facebook.com/NOVELOG-Project-412651338922161/?fref=ts
- NOVELOG twitter: https://twitter.com/NOVELOG_project
- NOVELOG linkedin: https://www.linkedin.com/groups/8384147/profile

4. Using the Evaluation Tool

4.1. Tool Handling

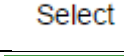
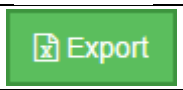
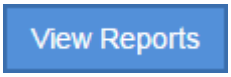
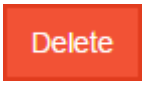
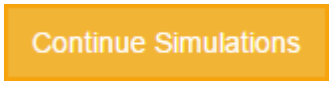
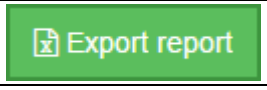
To navigate into the Evaluation Tool the user may use two main buttons: a) *Proceed,* and b) *Back* (browser's go back button) as shown in Table 4.1.

Table 4.1 Navigation buttons

Proceed button	By clicking *'Proceed'* the user may continue to the next step of the evaluation process while all progress up to that point is being saved.	
Back button	By clicking the *'Back button'* of the browser, the user may return to the previous step of the evaluation without saving the progress.	

For navigating in the Evaluation Tool the user may also use the following buttons (Table 4.2):

Table 4.2 Additional navigation buttons

Select	Select a Case study in 'HISTORY' menu	
Export	Export of data in Microsoft's Excel Worksheet	
Add	Add a new primary or secondary objective	
View Weights	Navigation to the window of generated weights	
View Reports	Navigation to the window of aggregated scenario results	
Create Scenario Copy	Create an identical scenario under the name 'Copy- …'	
Delete	Delete a certain scenario	
Continue Simulation	Finish a pending scenario	
Export Report	Exports a full case study results' report in a Microsoft's Excel Worksheet	
View Index Graph	Exports the web diagram per lifecycle stage for all selected Impact areas, before and after measure's implementation	

View LCI Graph	Exports the lifecycle index per Impact area	View LCI Graph

4.2. Default Menu

The NOVELOG evaluation tool is controlled from the menu sidebar in the welcome page (Figure 4.1). The menu directs the user in the evaluation tool as follows:

Home: The 'HOME' menu option is the initial display after having logged in with user's personal credentials (Figure 4.1).

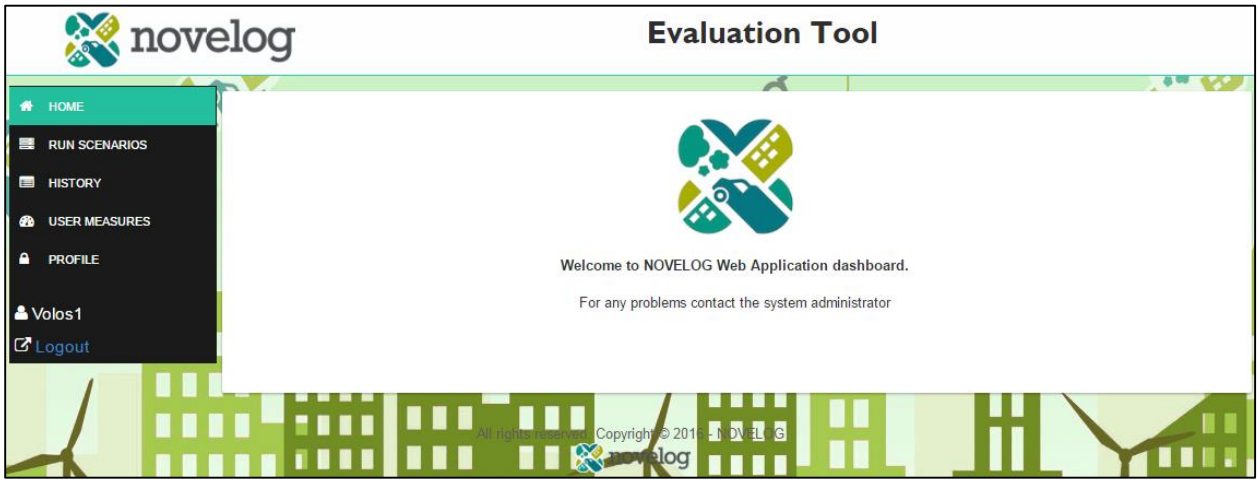


Figure 4.1 Default menu - Home

Modules: The "MODULES" menu option directs the user to any of the five available modules. The user may select any of the five modules as shown in Figure 4.2:

- Impact assessment module (section 4.4)
- Social Cost Benefit Analysis Module (section 4.5)
- Transferability and Adaptability Module (section 4.6)
- Risk Analysis Module (section 4.7)
- Behavioral Modeling Module (section 4.8)

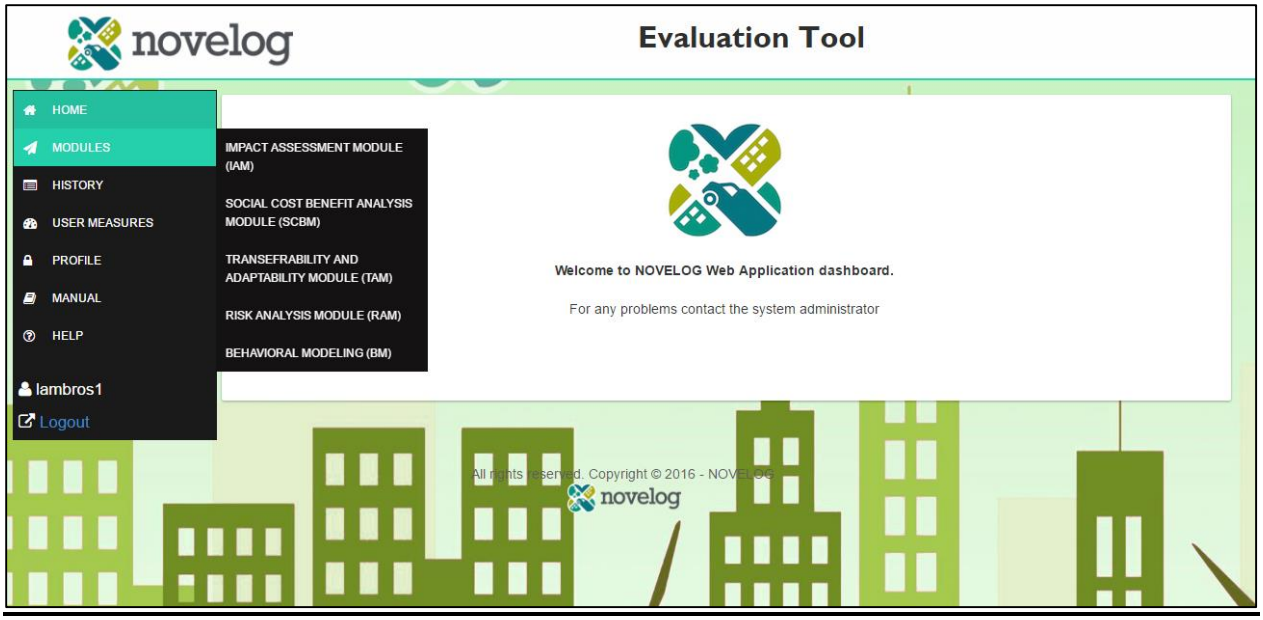


Figure 4.2 Default menu - Modules

After selecting any of the five available modules the user may create a new scenario to run by using the selected module ("New Scenario" button) or select a saved scenario that has run in the past ("History" button) as shown in Figure 4.3.

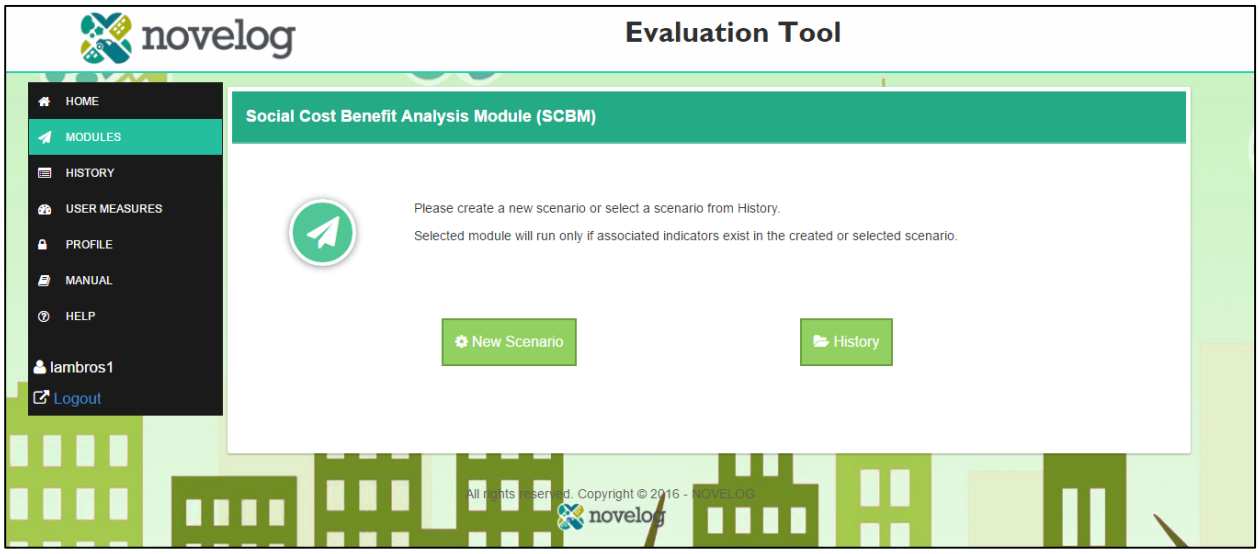


Figure 4.3 Selecting a scenario to run with a module

Run Scenarios: The 'RUN SCENARIOS' menu option launches the evaluation process of a case study. The interface of this window is organized in drop down menus with default options, check boxes and editable fields. The first two dropdown menus, namely 'Select City' and 'Select Stakeholder Category' cannot be edited, since they have been predefined in the registration process (Figure 4.4).

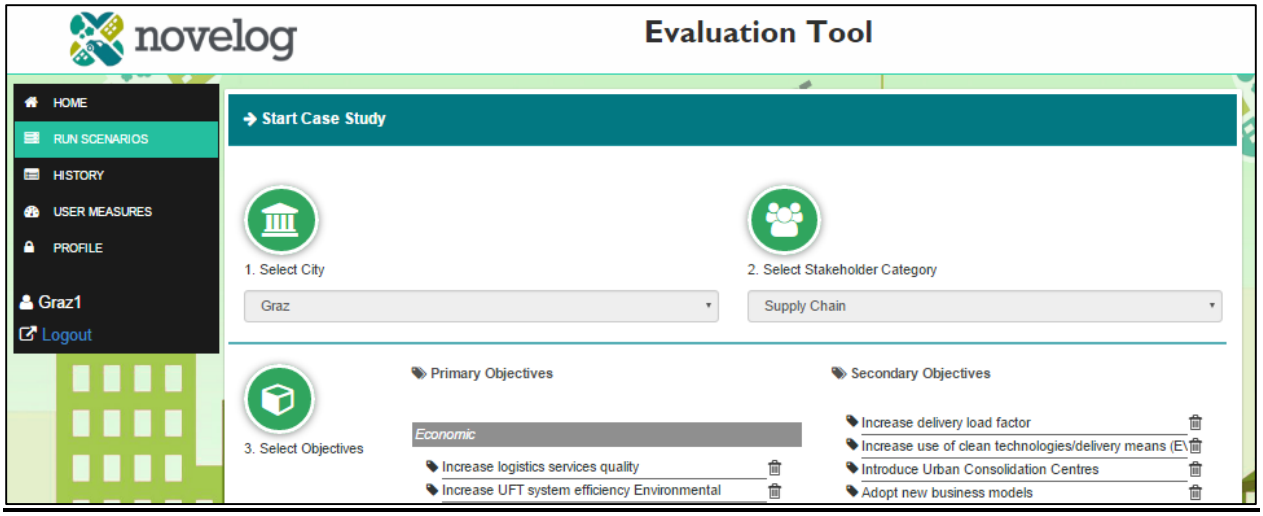


Figure 4.4 Default Menu – Run scenarios

History: The "HISTORY" menu option gives to the user the opportunity to retract already completed or pending scenarios based on measure selection. Through "HISTORY" the user may complete pending scenarios, export reports and graphs and check given indicators' values at any time.

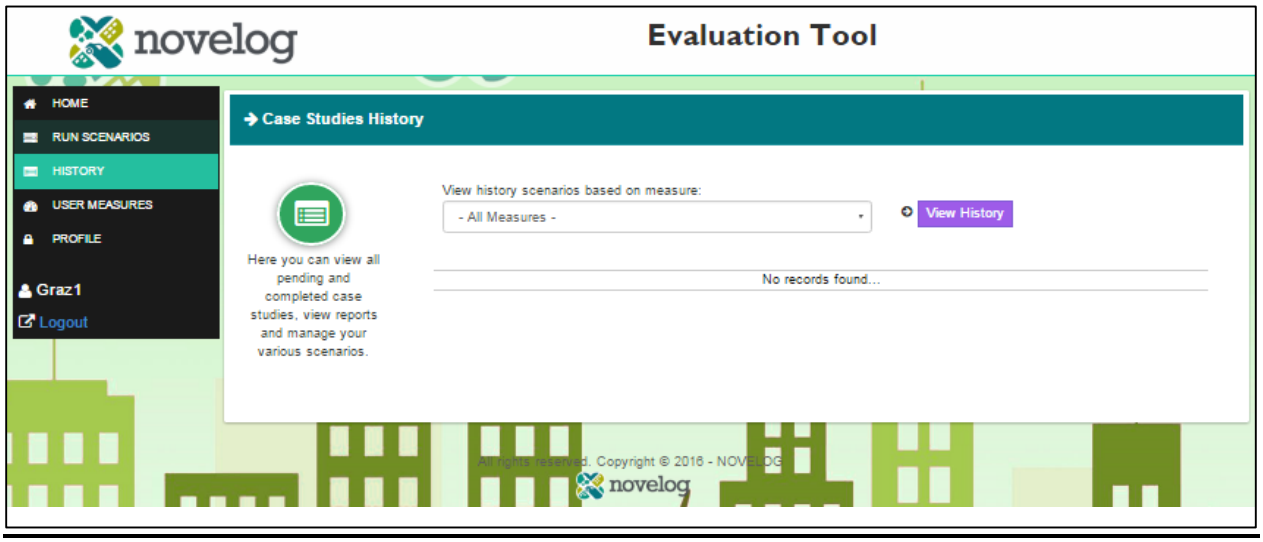


Figure 4.5 Default menu - History

Users Measures: In this version, NOVELOG's Evaluation Tool database is equipped with 22 Urban Freight Transport (UFT) measures (detailed description of measures in NOVELOG D3.1). However, the Evaluation Tool allows advanced users to create and submit new urban freight transport measures. In this case, the user should interrelate all corresponding components (Figure 4.6). The process for interrelating the components of the Evaluation Tool are described in detail in D3.2. Once, the system's administrator has approved the new measure request, all future users will be able to select it in their running scenarios.

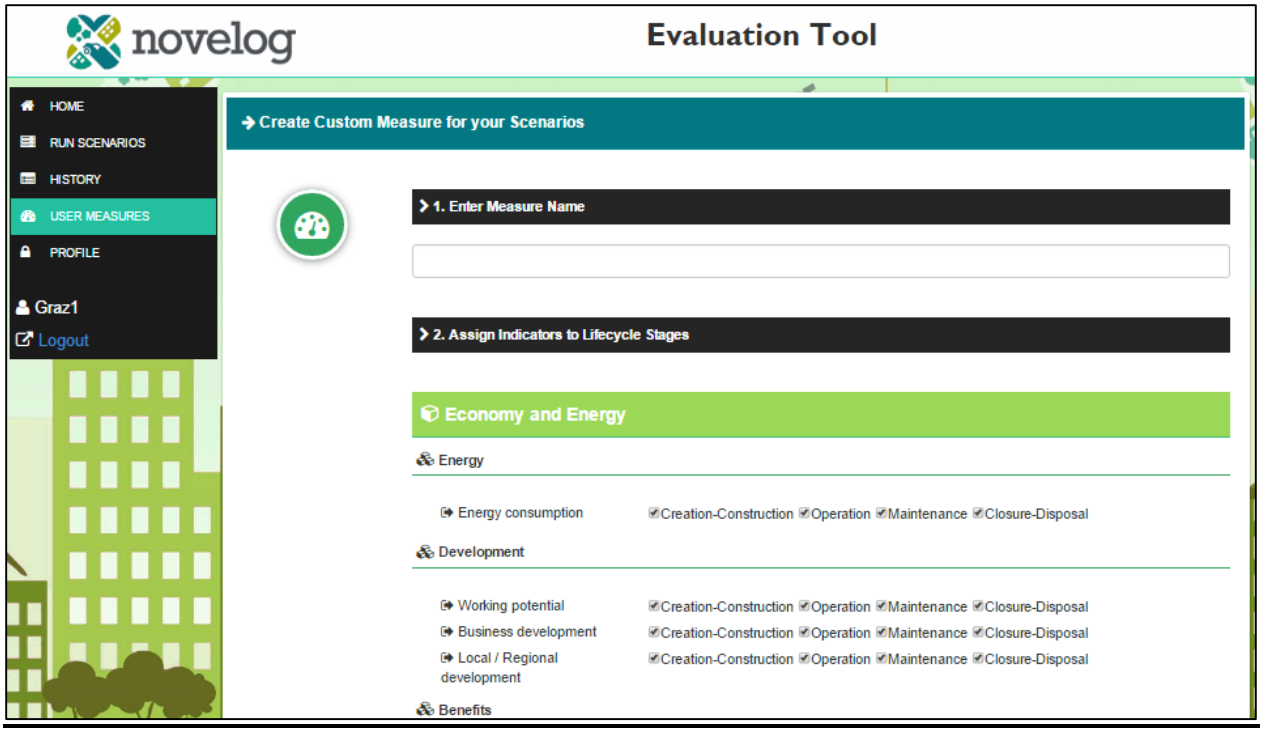


Figure 4.6 Setting up a new measure

Manual: The user may download the manual of the Evaluation Tool or any other supporting documents that are required to run the tool (Figure 4.7).

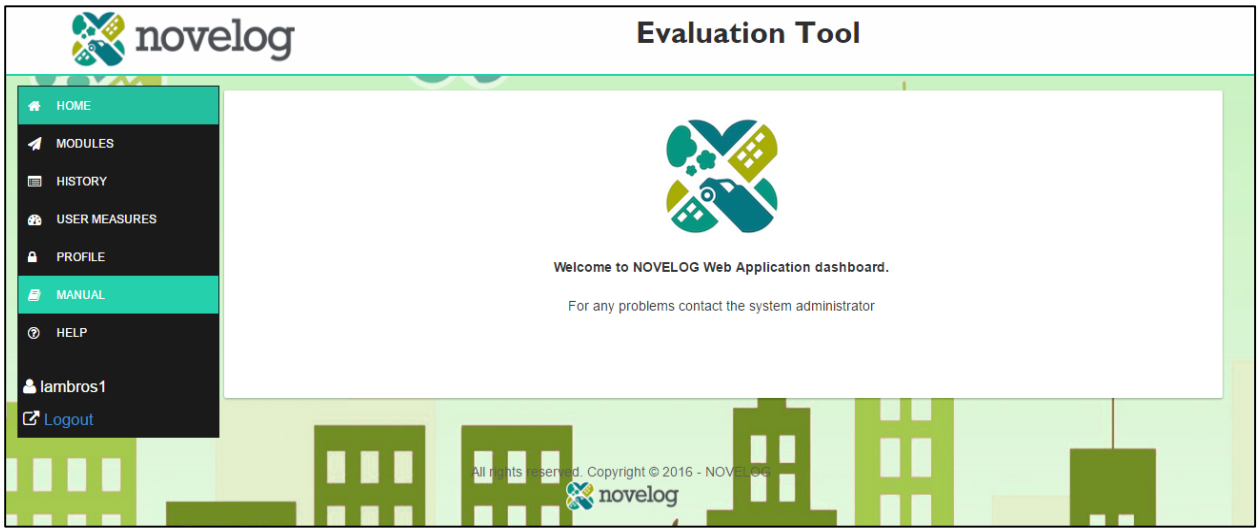


Figure 4.7 Default menu - Manual

Help: The 'HELP' menu option pop ups a window that shows to the user the available indicators in the Evaluation Tool categorized by impact area, criterion, and module (Figure 4.8). The user may also download the .pdf file.

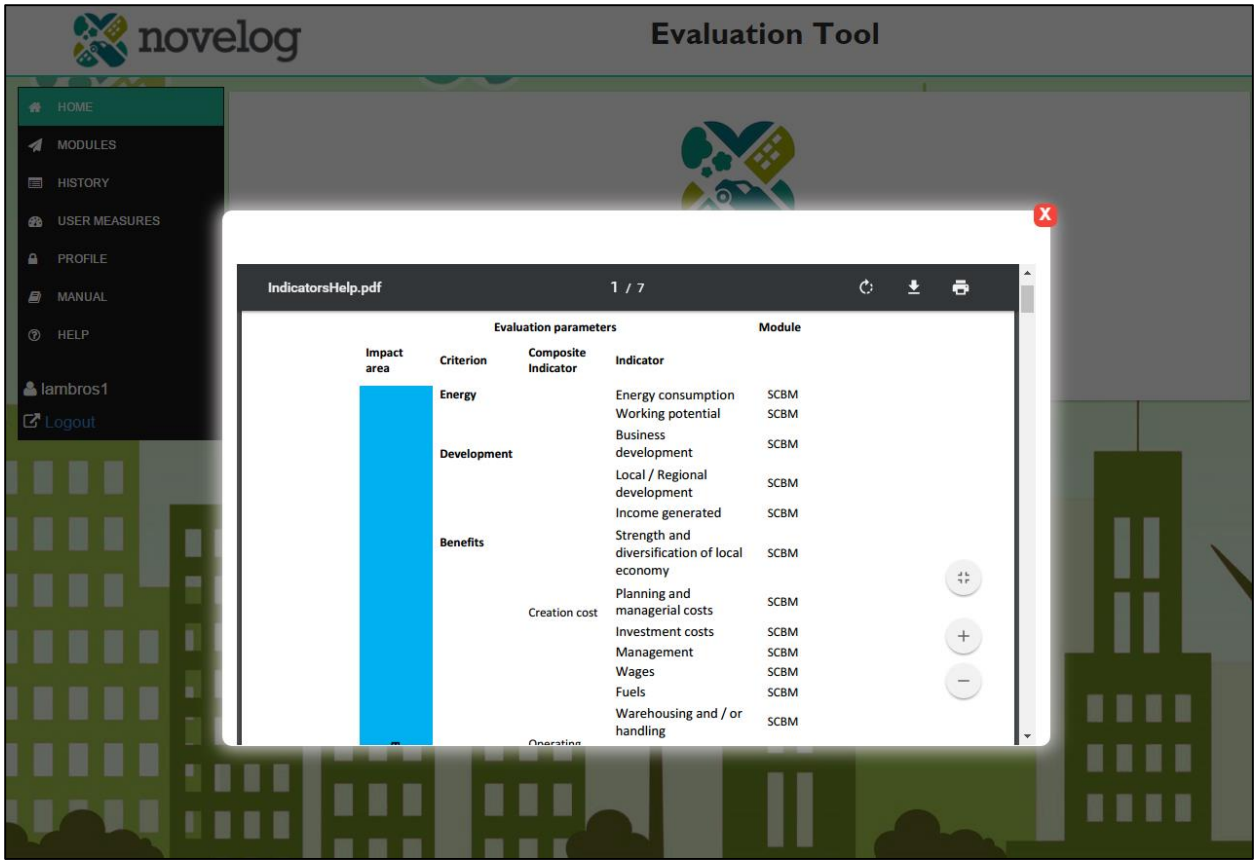


Figure 4.8 Default menu - Help

4.3. Multi-stakeholder Multi-criteria Decision Making

To evaluate the performance of a measure, the Evaluation Tool user is able to choose among indicators that are relevant to stakeholder categories and lifecycle stages. The interrelation of indicators with stakeholder categories was determined in NOVELOG D3.1 (NOVELOG, 2016d). The valid interrelation expresses that an indicator is considered in the evaluation process of a specific measure, since at least one aspect of the measure is assessed through this indicator. All verified correlations constitute the user's default options in the Evaluation Tool. The user can use all the default options (recommended) according to the generated matrix, or select some of those based on data availability (see D3.2 section 3).

4.3.1 Input data

The evaluation process starts by selecting the "Run scenarios" option from the main menu; the main window to start the evaluation process is displayed (Figure 4.9).

The user should select one of the 12 cities from the *"Select City"* drop down menu and one of the three available stakeholder categories he/she belongs to from the *"Select Stakeholder Category"* drop down menu. In the third step, the user reviews the primary and secondary objectives that have been set by the selected city. In this step the user may modify or delete any of the primary or secondary objectives that are linked to the city or add any other primary or secondary objective. Additional objectives are inserted by completing the blank cells below the primary or/and secondary objectives and clicking on the *"Add"* button.

Please note that primary objectives should be linked to one category that is selected from the drop down menu and then click the *"Add"* button.

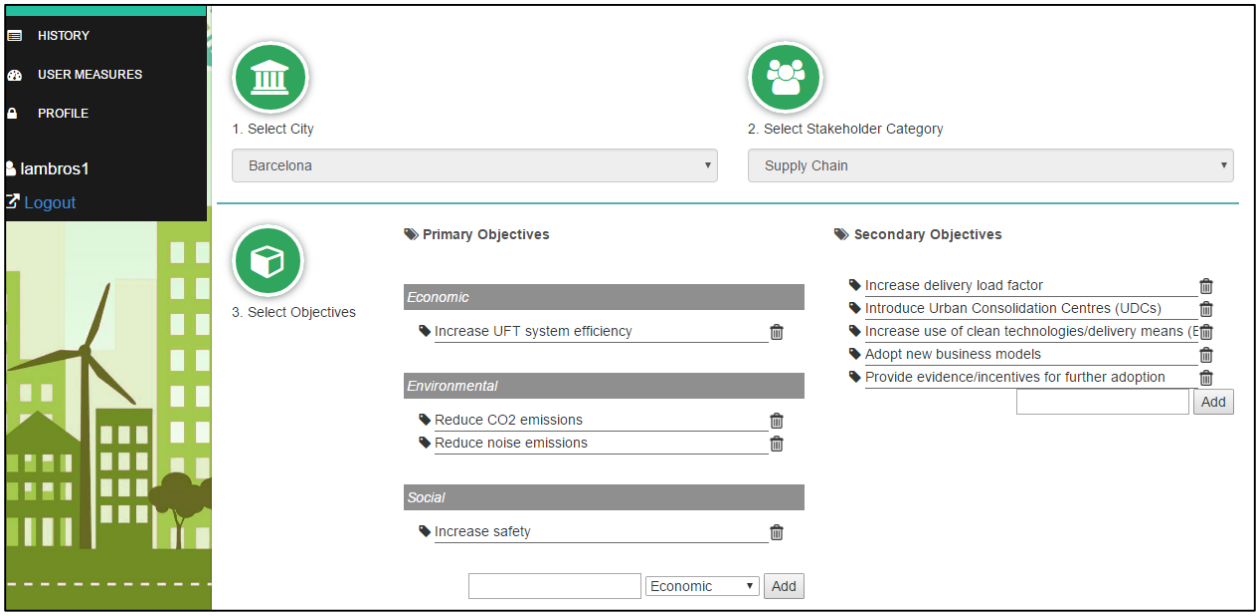


Figure 4.9 Setting up the evaluation (A)

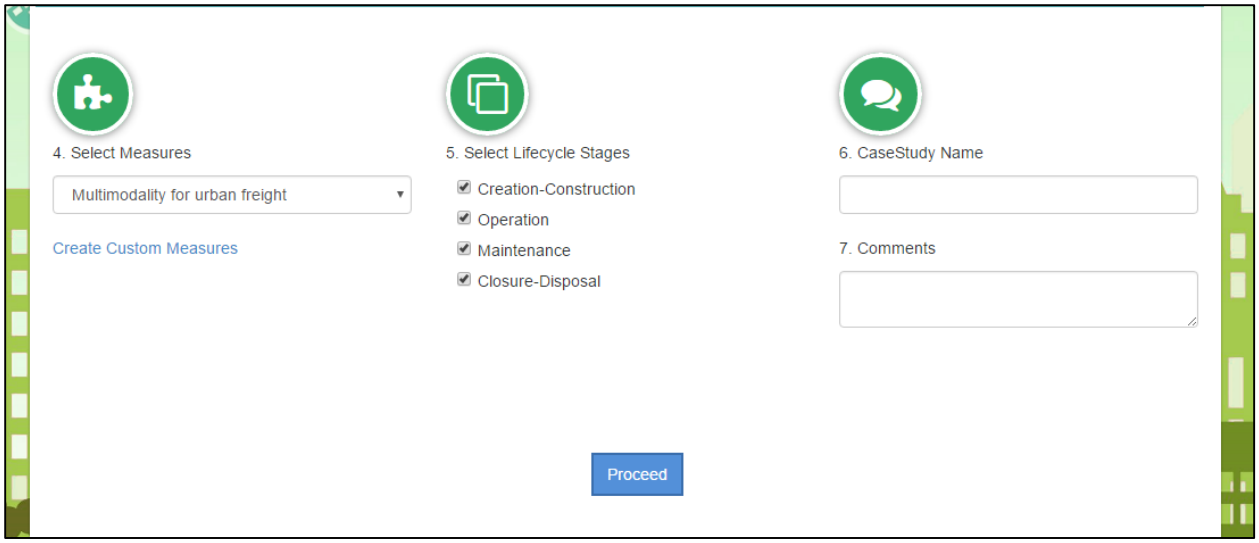


Figure 4.10 Setting up the evaluation (B)

In the fourth step of the main window, the user selects one of the 22 predefined measures (see D3.2 section 2.3.4). The user may also select to create a custom measure either by clinking on the link *"Create Custom Measures"* or by selecting the option *"User Measures>Create"* from the main menu. Following the measure selection, the user should select at least one of the four lifecycles by keeping clicked the box next to each desired stage. The lifecycle stages that are applicable to each selected measure are preselected by default. Finally, to enable running of the

process the user should provide a case study name by completing step six. In case that the user clicks on *"Proceed"* prior to completing all mandatory fields, a red asterisk appears next to the step that has not been modified or accepted input by the user. Step seven *"Comments"* is not a mandatory field, the user may provide a short description of the case study that will run for reporting purposes. After completing all required fields, the user proceeds to the next window by clicking on *"Proceed"* (Figure 4.10).

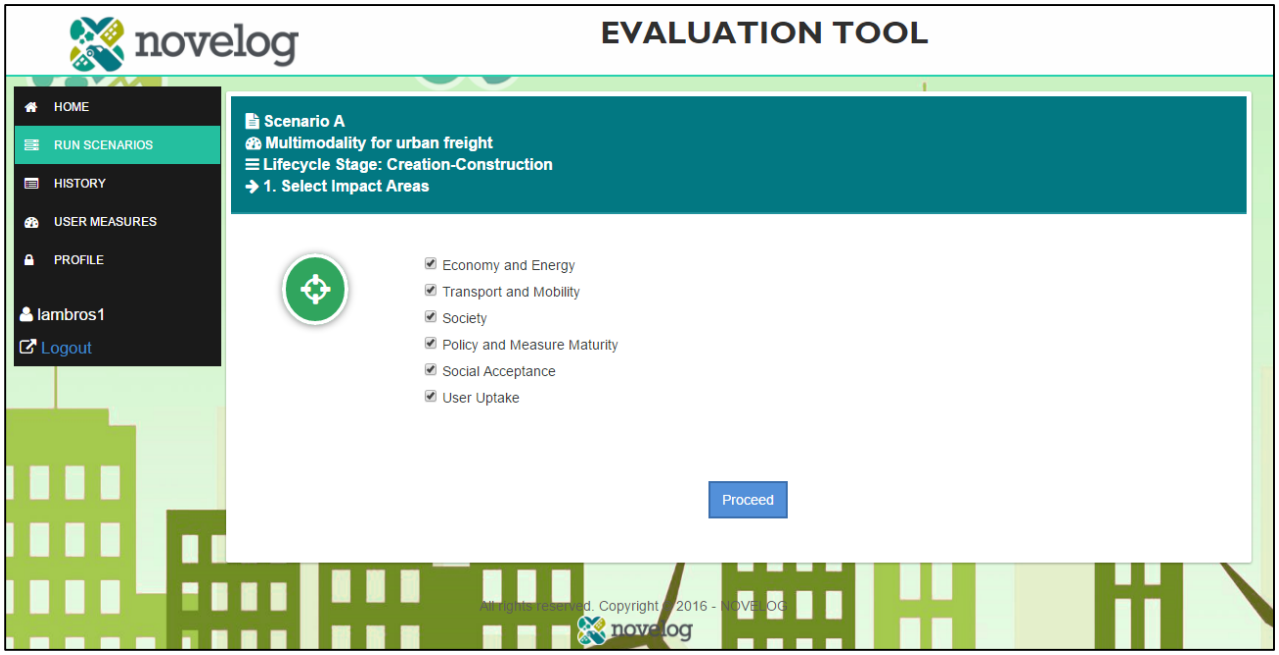


Figure 4.11 Selecting impact areas

In the next window (Figure 4.11) the user may find all impact areas that are interrelated to the selections that has made in the main window. All applicable impact areas are selected by default. The user may proceed to the next page by keeping selected (i.e., clicked) all desired impact areas. The user may keep track of the step-by-step process by reading the summary on the top of the page. Please note that in case the user has selected more than one lifecycle stages in the main window, he/she will complete the process that is described from Figure 4.11 to Figure 4.20 for each lifecycle stage. For example if the user has selected in step 5 of the main window two lifecycle stages (i.e., operation and maintenance) then the setting up process (Figure 4.11 - Figure 4.20) will be run two times.

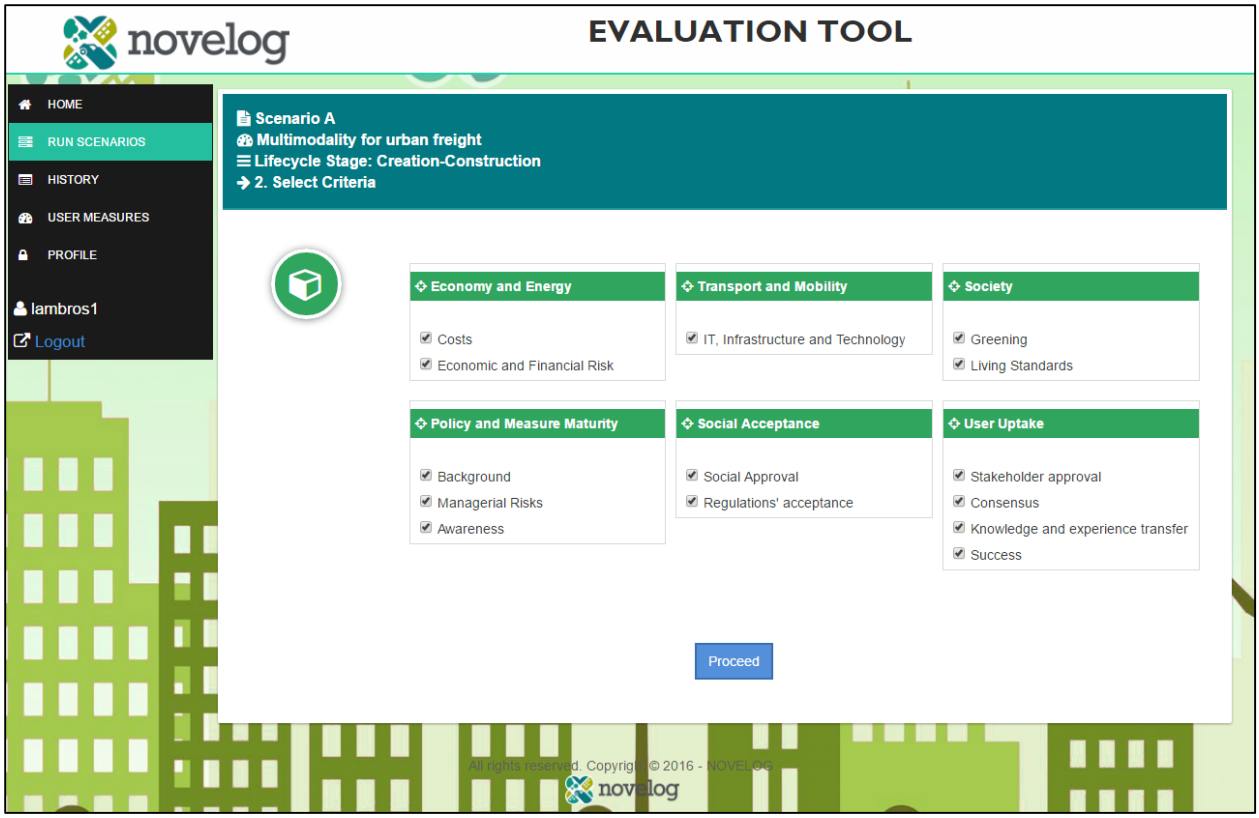


Figure 4.12 Selecting criteria

Following the same logic, the next page (Figure 4.12) presents all applicable criteria to the selected measure grouped per impact area for each selected lifecycle stage. In this window the user should deselect all criteria that should not be included in the assessment. The next window (Figure 4.13) allows the user to see all selected impact areas (Impact area Tabs) and for each active impact area (highlighted in light green) to select the indicators that desires to be included in the assessment. Indicators are grouped and presented in this window per criterion and impact area.

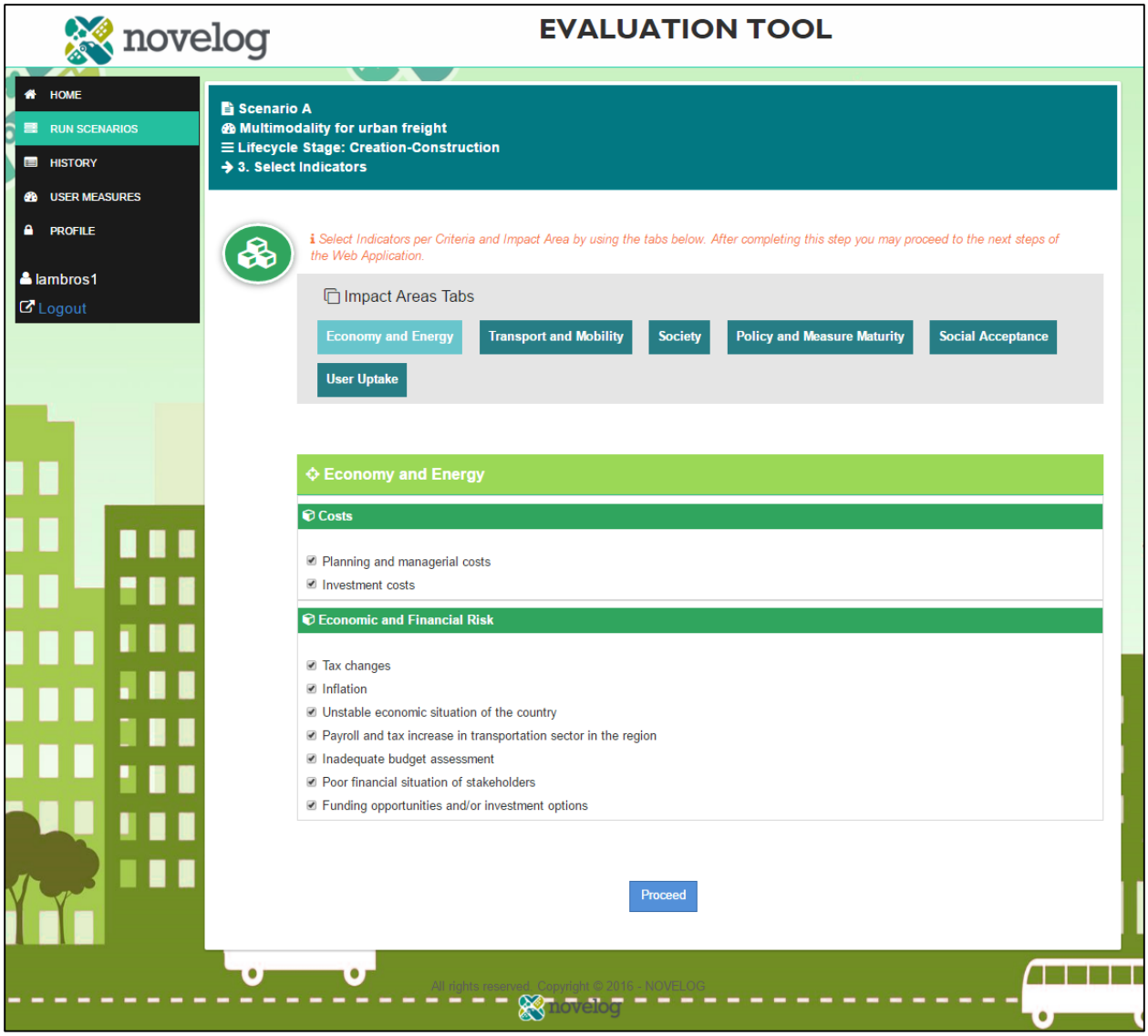


Figure 4.13 Selecting indicators

The user should review all impact areas before proceeding to the next page. If the user omits to review any of the impact area tabs then a warning message (Figure 4.14) pops up that instructs the user to review the impact areas that are still pending.

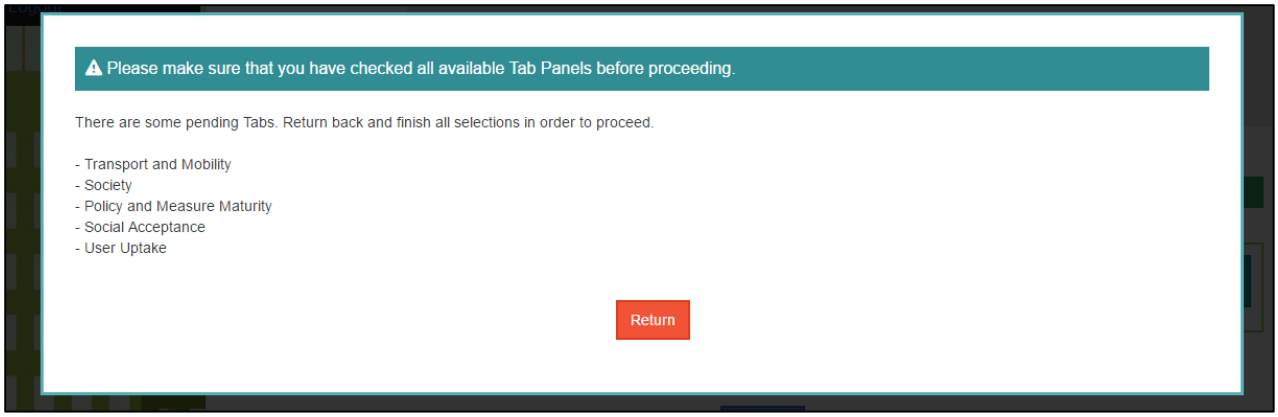


Figure 4.14 Warning message

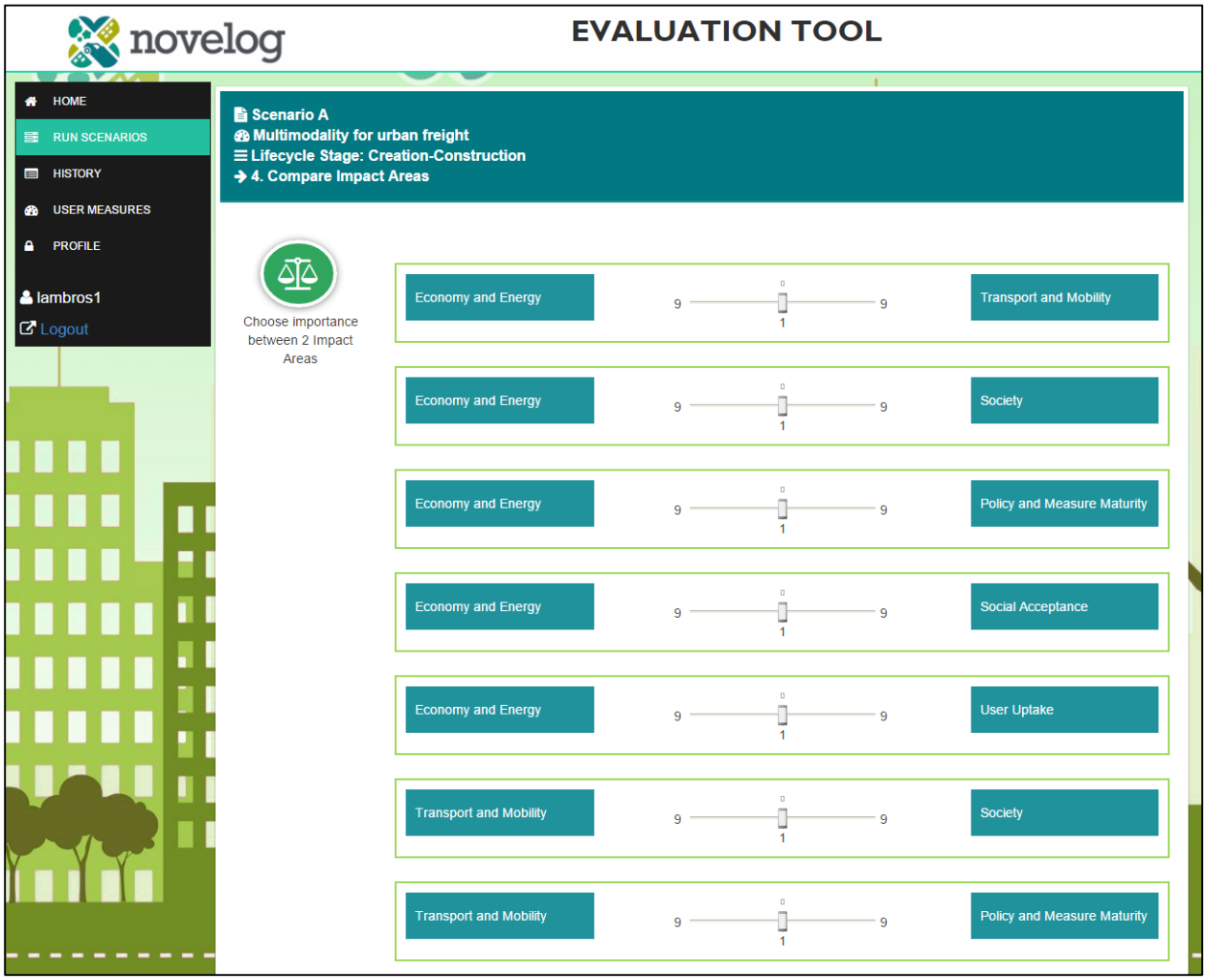


Figure 4.15 Weighing impact areas

The next window (Figure 4.15) provides to users the opportunity to assess the relative importance of their selections in previous steps, including weighing of impact areas, criteria and indicators. The user conducts a pairwise comparison of each element as shown in Figure 4.15 for impact

areas. The pairwise comparison is enabled by ranking from 1 to 9 the relative importance of each element relative to the other. The details for the pairwise comparison method are described in D3.2 section 4.1.1 (NOVELOG, 2016e). Weights are generated based on the user's pairwise comparisons and the results of the weighing process are summarized in the next window (Figure 4.16).

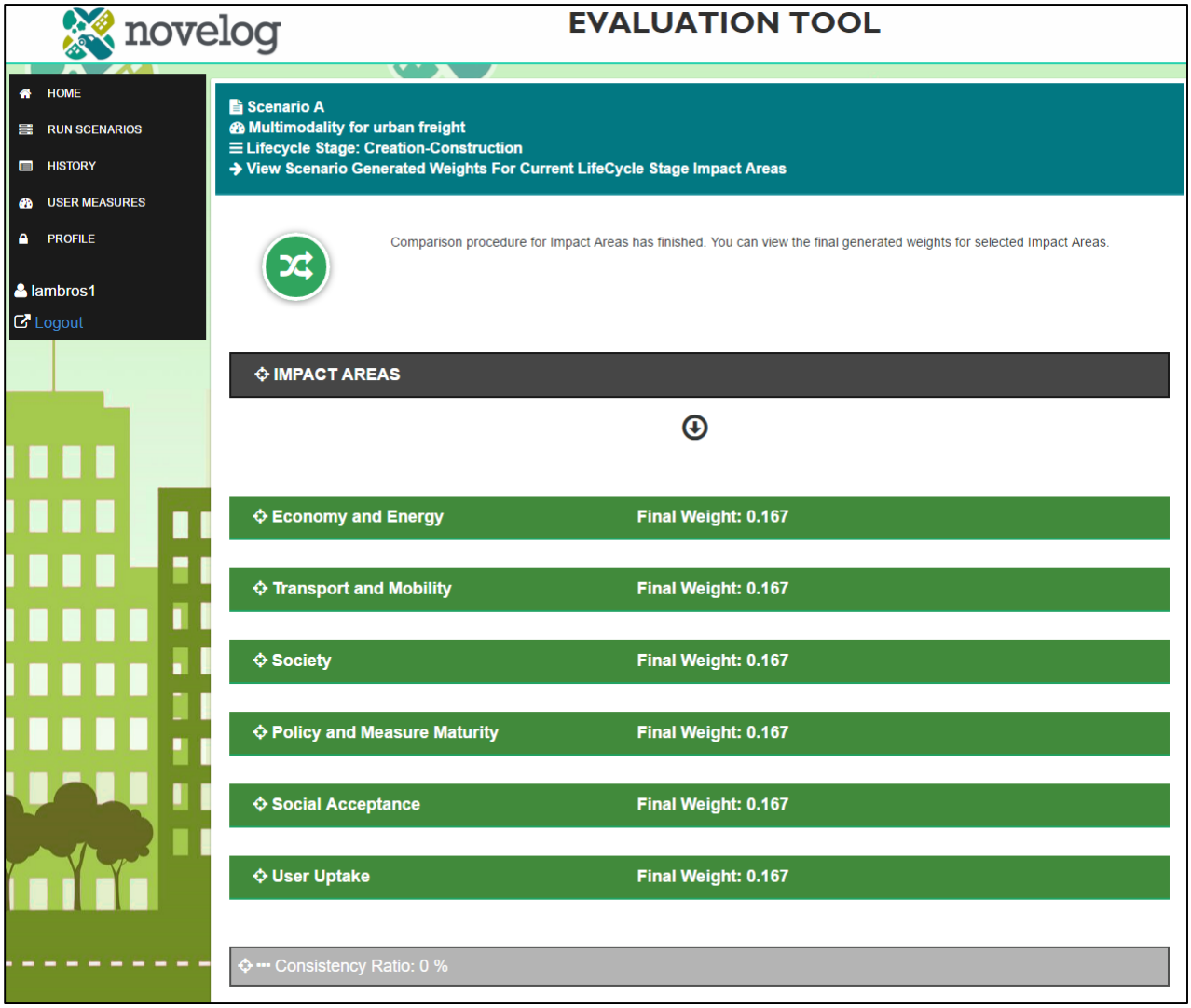


Figure 4.16 Summary of weighing impact areas

The same weighing process is followed for selected criteria and indicators for each selected lifecycle stage and the results are summarized after completing each weighing process. The user should select all impact area tabs and review the weights for all selected criteria as shown in Figure 4.17.

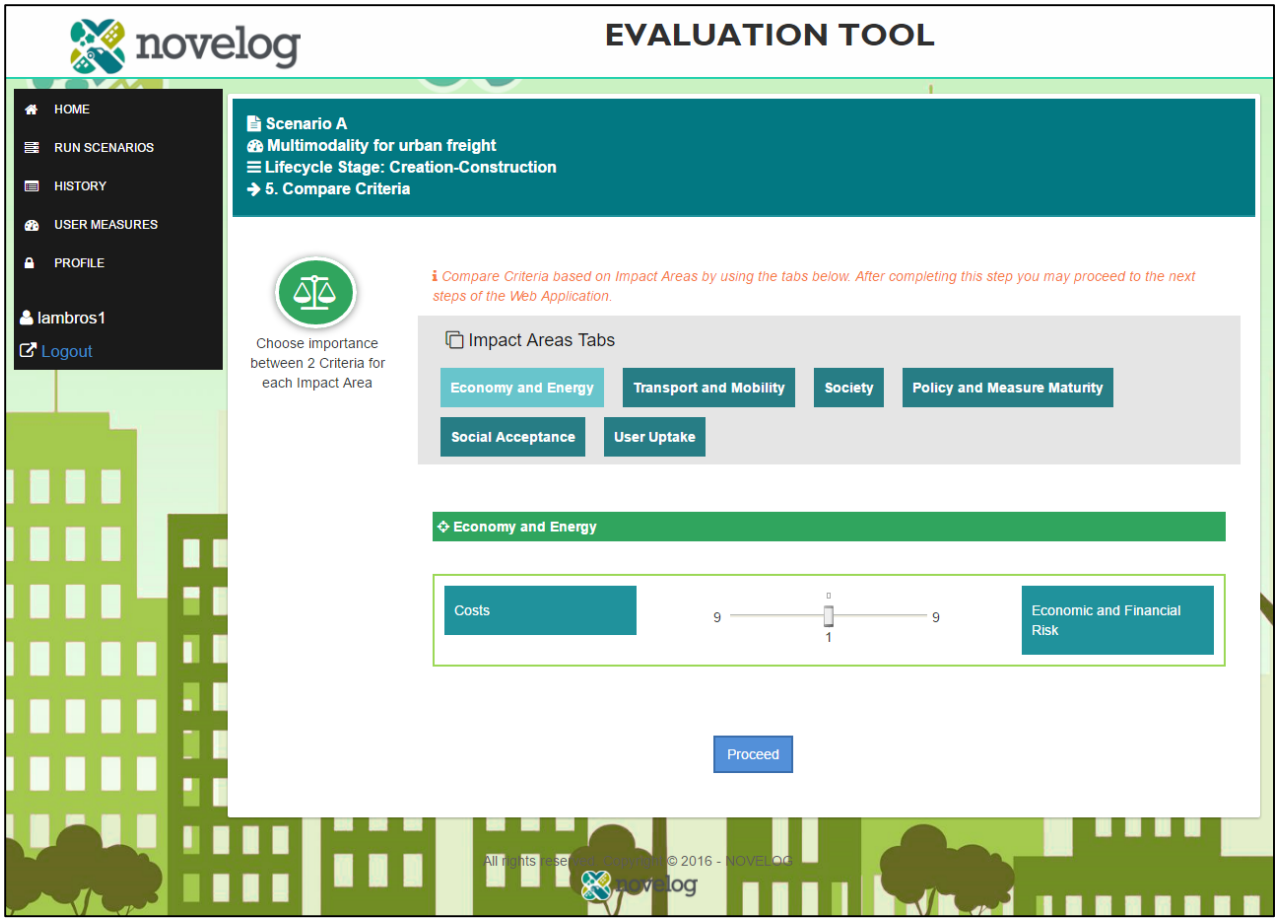


Figure 4.17 Weighing criteria

After finalizing the weight process for selected impact areas, criteria and indicators the generated weights per element can be reviewed in the summary window (Figure 4.18). The generated consistency ratio that shows the consistency of the weighing process (details in D3.2, section 4.2) is shown at the end of each element's level. Usually, a consistency ratio of up to 10% is considered as good consistency however, higher values (e.g. up to 30%) may be also acceptable. Final weights per impact area, criterion and indicator can be exported at this stage by clicking the button *"Export"*.

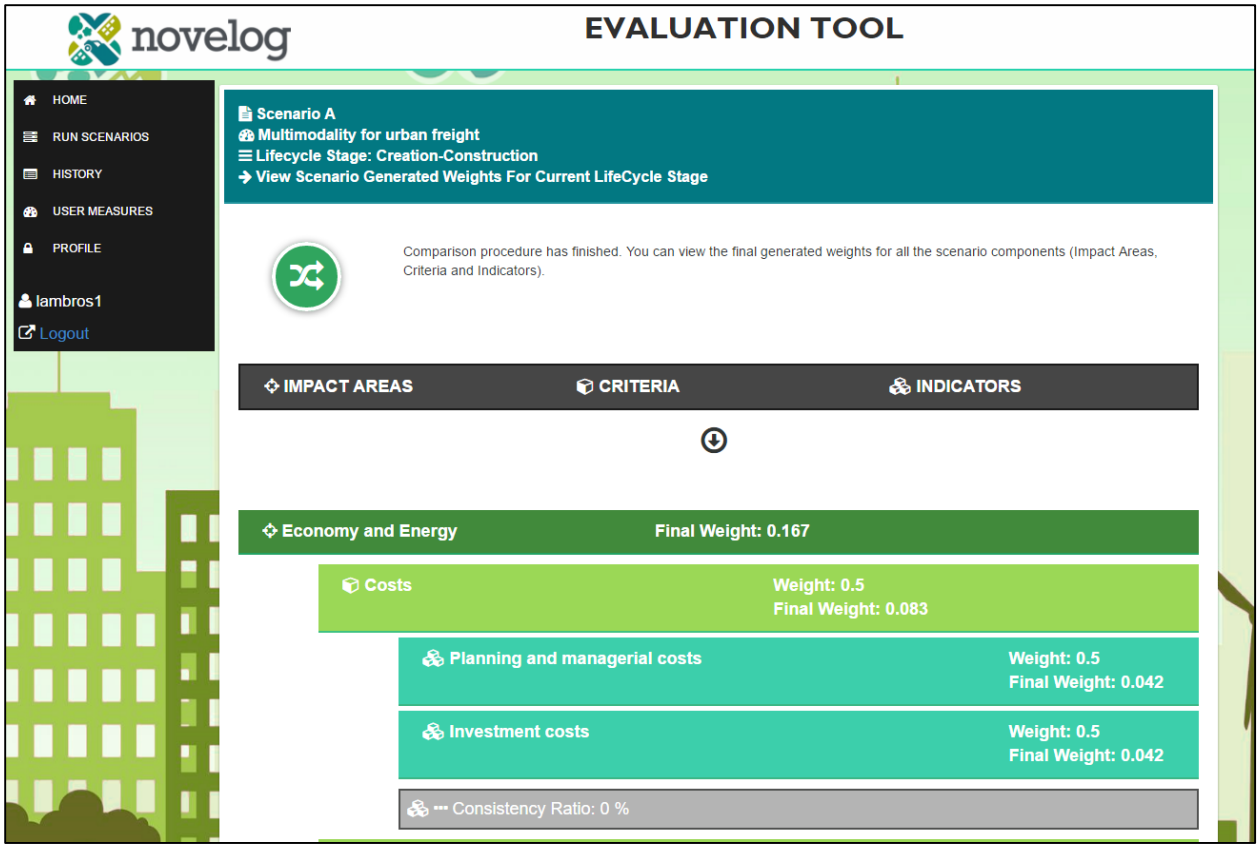


Figure 4.18 Summary of weights per element

The next window (Figure 4.19) prompts the user to enter data values for before and after measure implementation. Indicators are quantitative and qualitative and for all of them a short explanation is provided to lead the user. Units and explanation of Likert scale, where applicable, is provided in the column *"Units".* The Likert scale is shown to the user after clicking on the button *"Show Likert Scale".* After completing the required data, the user may proceed to the next stage by clicking on *"Proceed"* to finish all steps without generating reports or to save the current setup and finalize the evaluation at a later time by clicking on the button *"Save and Continue".*

After completing this step the user may proceed to the next steps of the Evaluation Tool. After completing successfully the process that it was described from Figure 4.11 to Figure 4.20 per selected lifecycle stage the user receives a message that the set of the current lifecycle stage was completed successfully. If more than one lifecycle stages were selected in the main window (Figure 4.10), then the user repeats the process as described before.

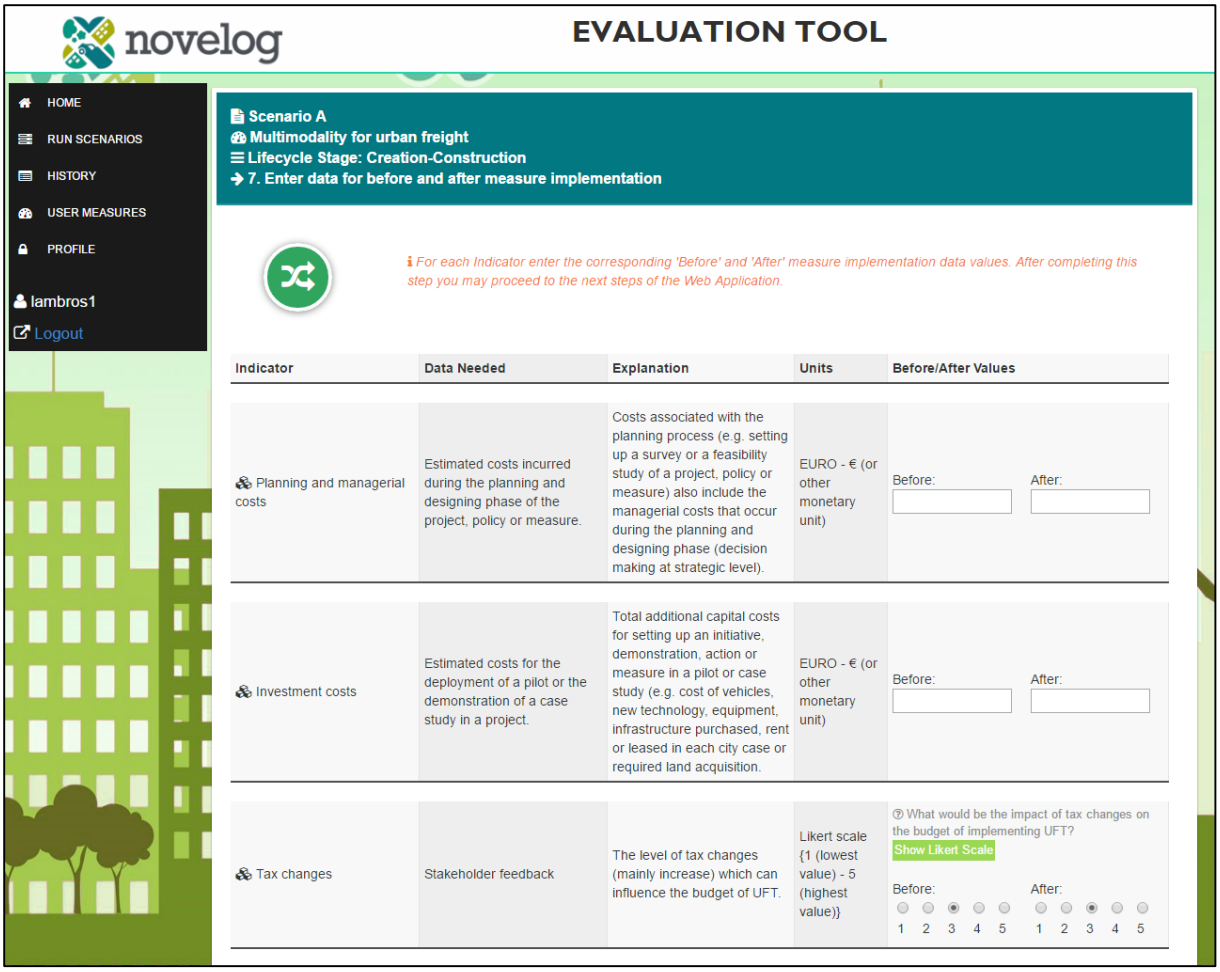


Figure 4.19 Entering data values

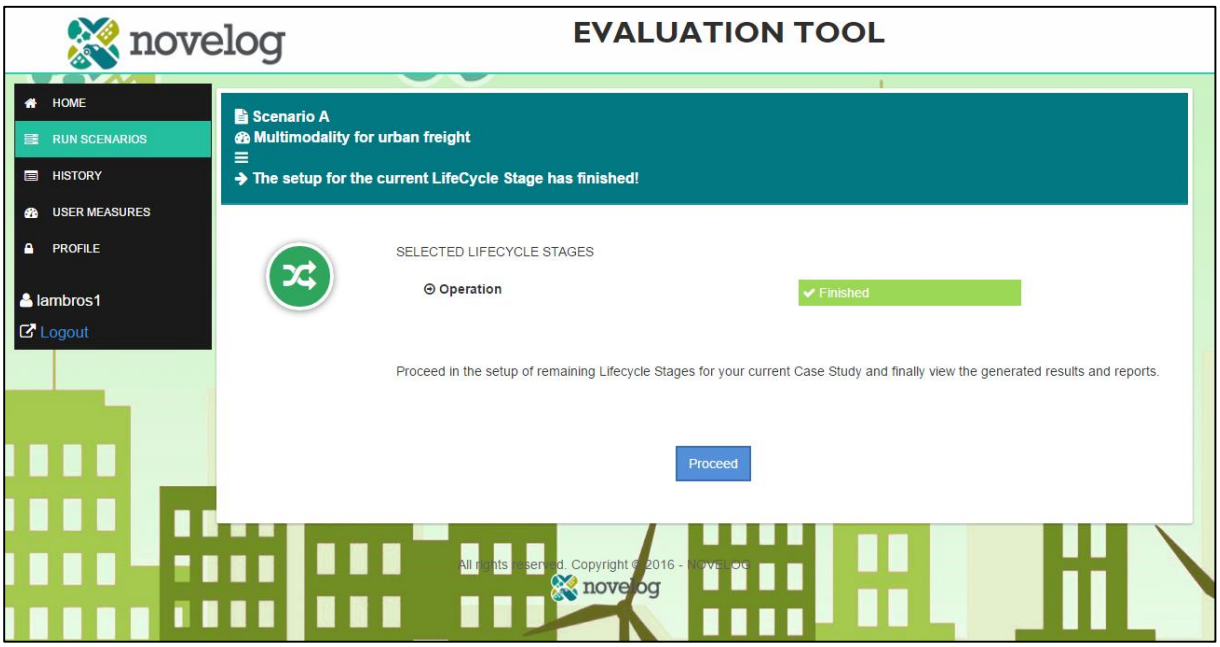


Figure 4.20 Successful data entry for selected lifecycle stage

4.3.2 Output data

The Evaluation Tool aggregates selected components (i.e., indicators, criteria, impact areas, etc.) into indices to enable assessment of measures for a before-after based scenario and comparisons between measures. For each measure the Evaluation Tool generates the four following indices:

A. Index per impact area per lifecycle stage

B. Index per impact area for the measure's lifecycle

C. Index per lifecycle stage

D. Logistics Sustainability Index (LSI)

Each index is generated for the stakeholder category that the user belongs in. Indices are described in detail in D3.2 section 7.3. The results screen summarizes the user selections and provides the LSI (i.e., index D) for the selected measure (Figure 4.21) for before and after cases.

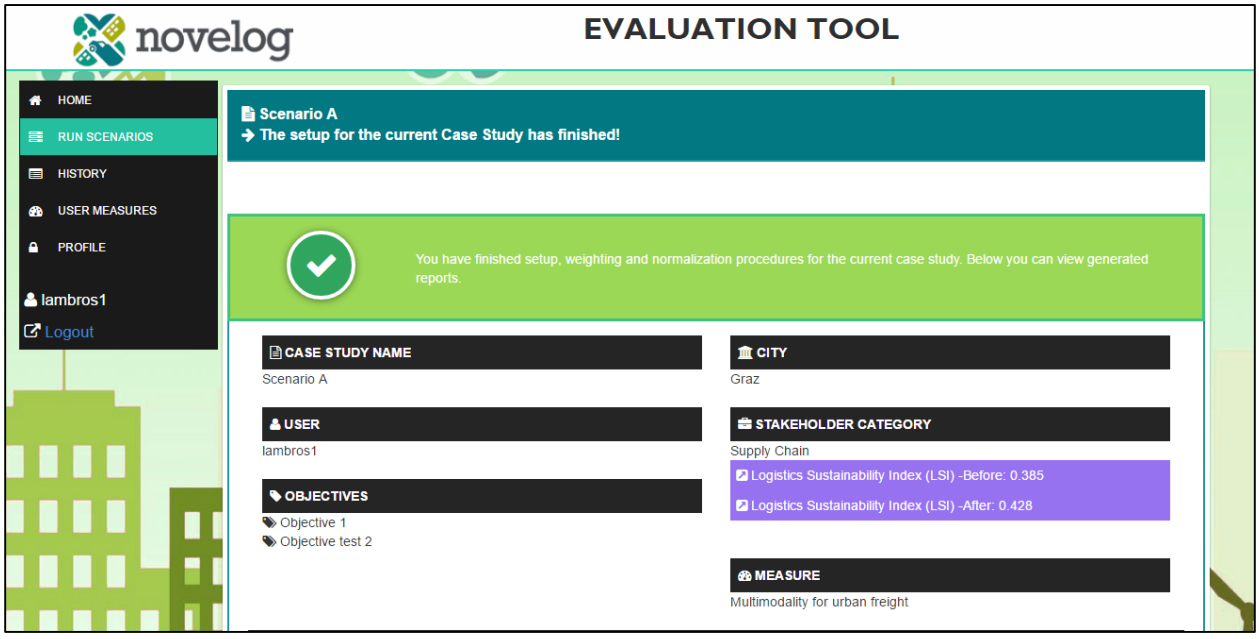


Figure 4.21 Generated logistics sustainability index

The index per lifecycle stage (i.e., index C) for before and after cases is shown in Figure 4.22 for the corresponding lifecycle stage. The index per impact area per lifecycle stage (i.e., index A) for before and after cases is shown in Figure 4.22 below the corresponding lifecycle stage. The user may review the final weights per impact area, criterion and indicator by clicking on the button *"View Weights".*

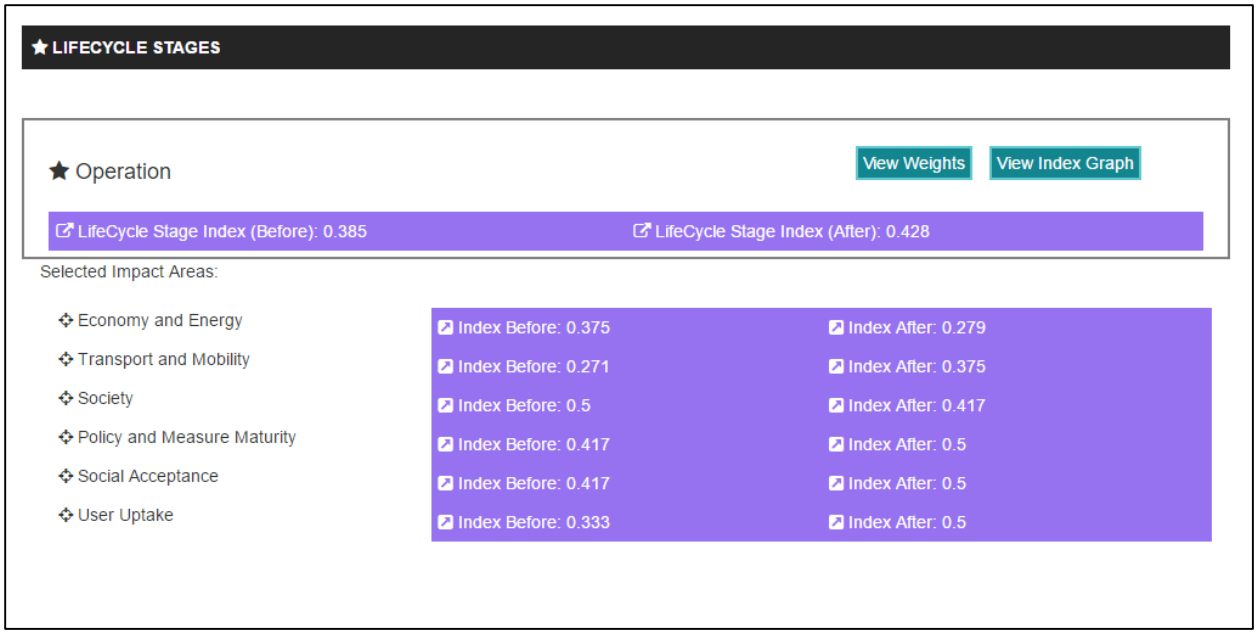


Figure 4.22 Generated indices per lifecycle stage

The index per impact area for the measure's lifecycle (i.e., index B) for before and after cases is shown in Figure 4.23. At the end of this page the user may review all selected indicators and their values by clicking on the link *"Show indicators…"*

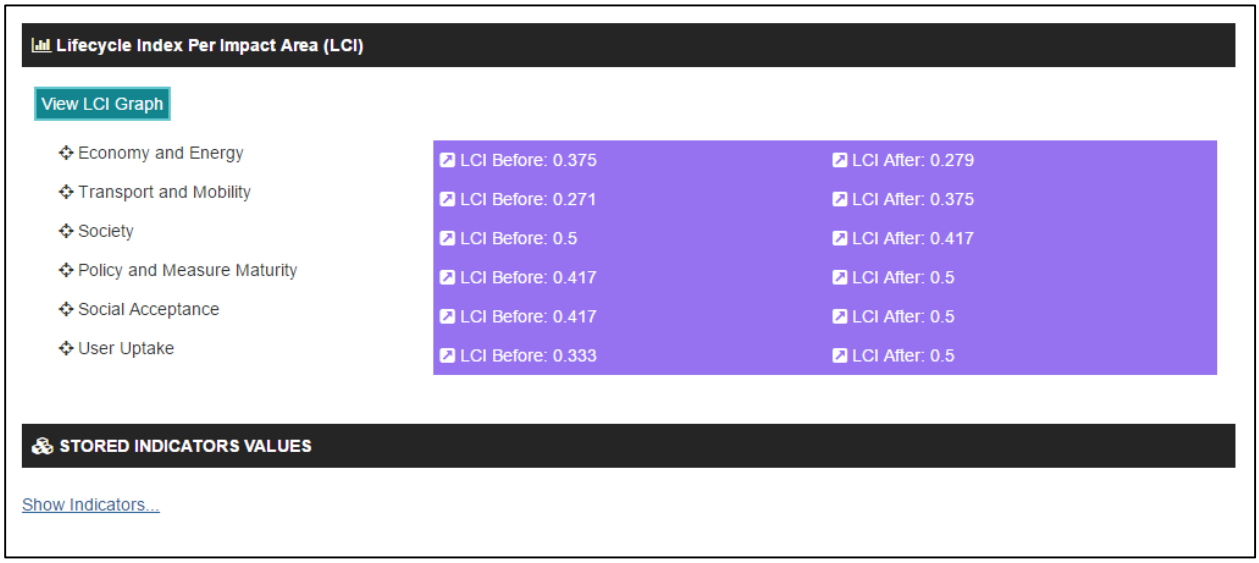


Figure 4.23 Generated lifecycle index per impact area

4.3.3 Graphs

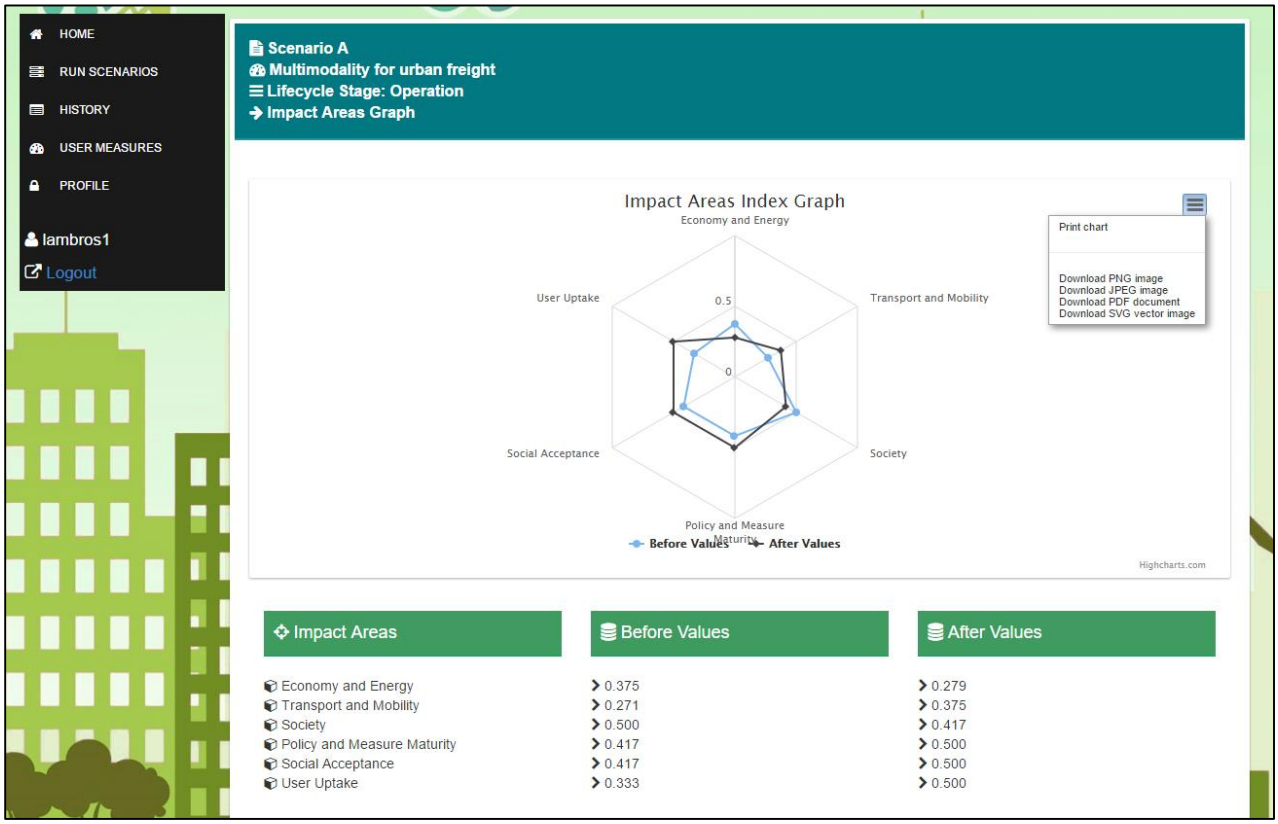


Figure 4.24 Visual representation of results

A graph is used to summarize visually the outputs per impact area for the measure's lifecycle by clicking on the button *"View LCI Graph"* (Figure 4.23) and per lifecycle stage by clicking on the button *"View Index Graph"* (Figure 4.22). Each corner of the polygon (a polygon is shaped if more than two impact areas have been selected for the evaluation process) represents one of the impact areas selected and illustrates indices of assessed measures for each impact area for before and after cases, as shown in Figure 4.24. The graph may be exported for printing or downloading in different formats (i.e., .png, jpeg, pdf, .svg) by clicking on the  icon.

4.4. Impact Assessment Module

4.4.1 Input data

The Impact Assessment Guidance (IAG) module can be accessed by following the link:

The module supports the city stakeholders in two ways (functions):

A. **Indicator-based function:** It suggests methodologies and models/tools for the estimation/calculation of indicators, based on the user's indicator preferences. The main question addressed here is: *how can I calculate/estimate the indicator(s) of my choice?*

B. **Model-based function:** It provides the impacts and indicators that could be estimated/calculated by specific models/tools, based on the user's model/tool preferences. The main question addressed here is: *given that I have access to a specific model/tool, which indicators can I calculate/estimate?*

A. Indicator-based function

The IAM user interface operates in four (4) levels (i.e., impact area, criteria, composite indicators, indicators) following the hierarchy of the Impact Assessment (IA) indicators.

The first level is related to the impact areas of Environment and Transport & Mobility (Figure 4.25). The user can either select one of the areas or all.

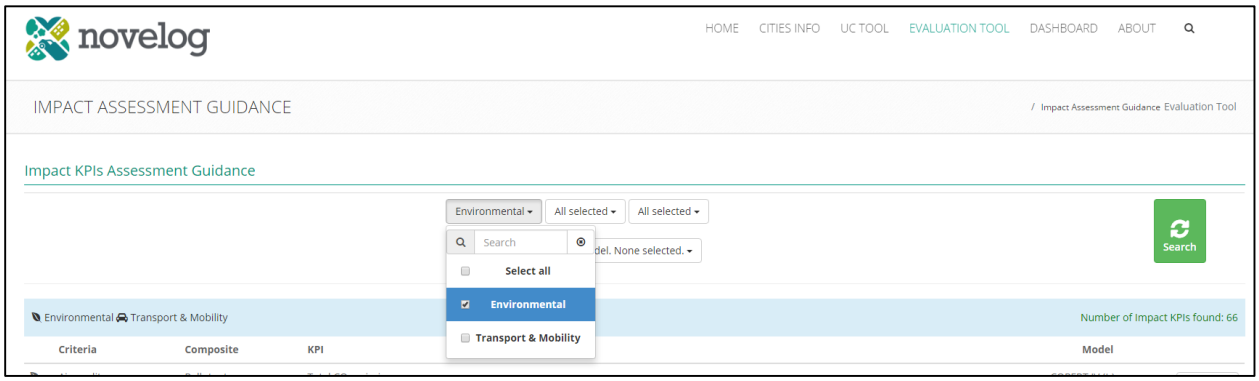


Figure 4.25 Selecting impact area

The second level is associated to the IA criteria (Figure 4.26). Again, the user can either select specific criteria (multiple choice) or all.

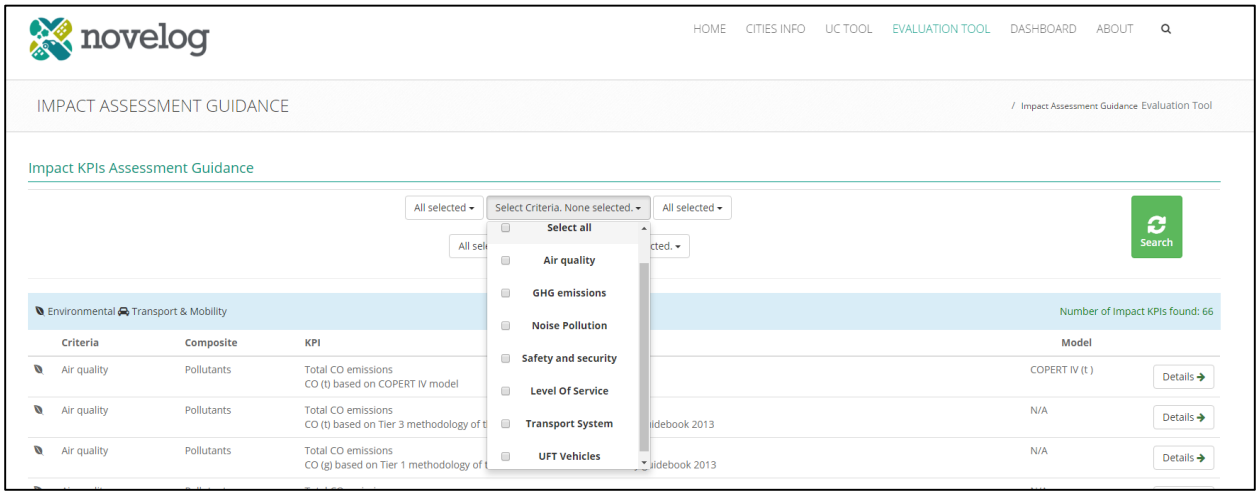


Figure 4.26 Selecting criterion

The third level is related to the selection of the composite indicator (Figure 4.27). The same as above applies for the user's selection. It should be noted here that, within the Evaluation Tool, the

user has the option to proceed with the estimation of the composite indicator instead of the integrated individual indicators. The selection window provided within the IAM allows for the specification of the composite indicator to the individual indicators.

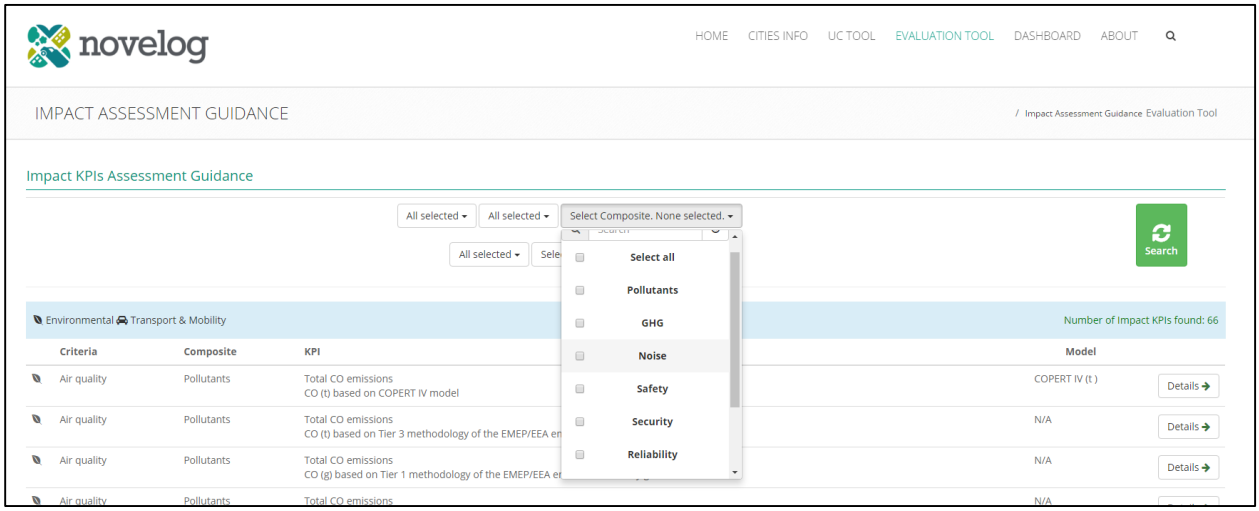


Figure 4.27 Selecting composite indicator

Finally, the fourth level allows for the selection of the desirable indicator (Figure 4.28).

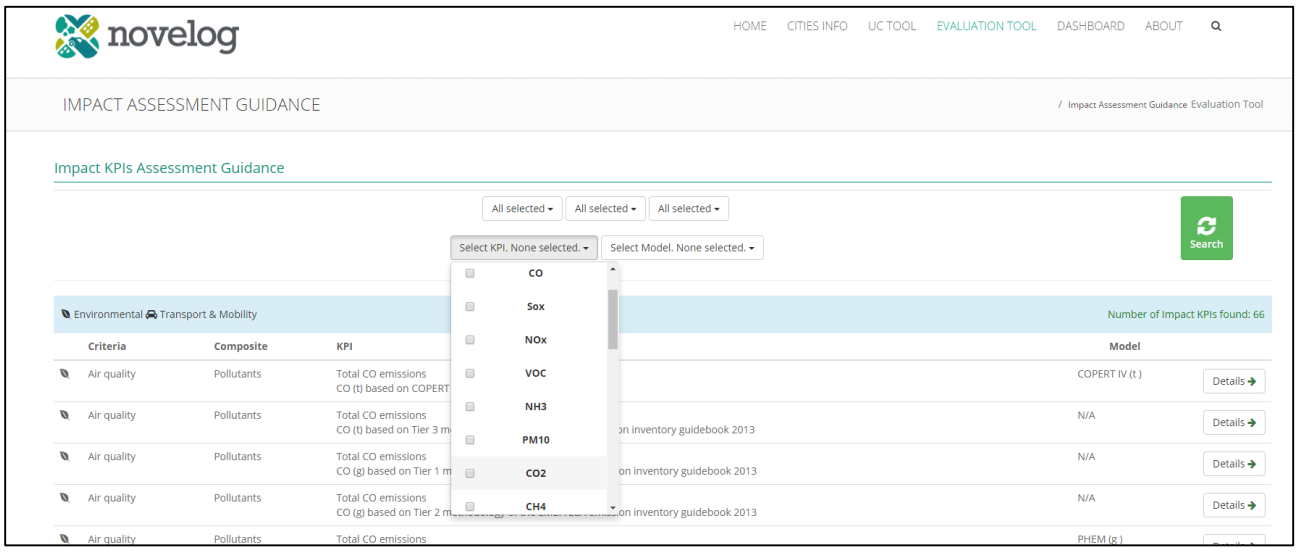


Figure 4.28: Selecting indicator

B. Model-based function

This function allows the user to select the model/tool (software packages/platforms) of his preference from a provided list. Then the module returns the impacts and indicators that can be quantified when running the selected model/tool (Figure 4.29).

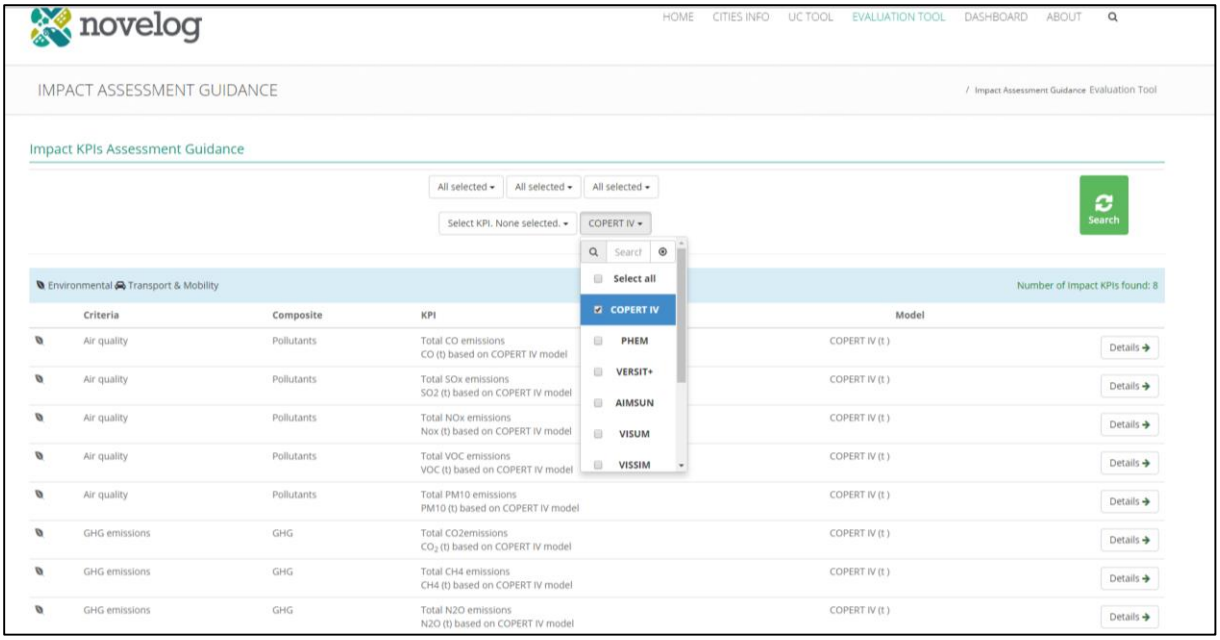


Figure 4.29: Selecting model/tool

The IAM receives as input from the Evaluation Tool all the information regarding the selection of the impact areas, criteria, composite indicators, indicators, thus allowing the user to skip the selection steps described above. Nonetheless, once the user is guided to the IAM, all the selection choices are open for possible desirable modifications.

4.4.2 IAM output

Once the desired selections have been made, the user clicks the search button and a list of the relative indicators with their models or methodological approaches appears. The list consist of the main information about each indicator with a short description (Figure 4.30).

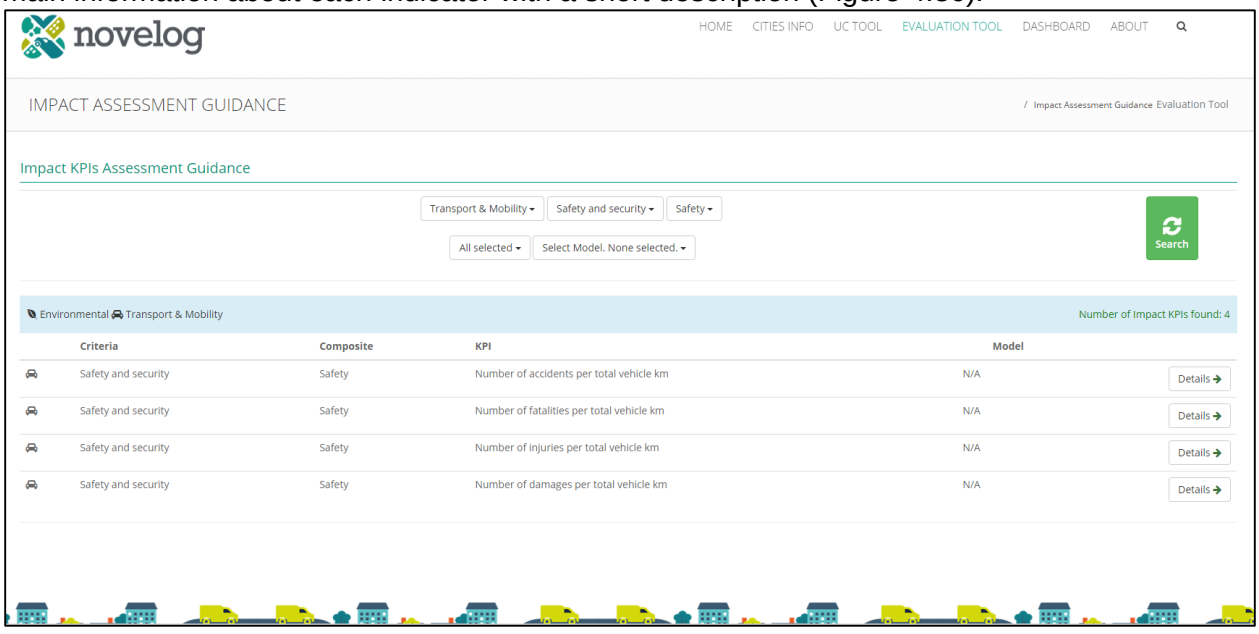


Figure 4.30 Providing list of relevant indicators based on criteria selection

Upon selection of the enabling tool/model, the IAM returns the list of indicators that could be measured/estimated (Figure 4.31).

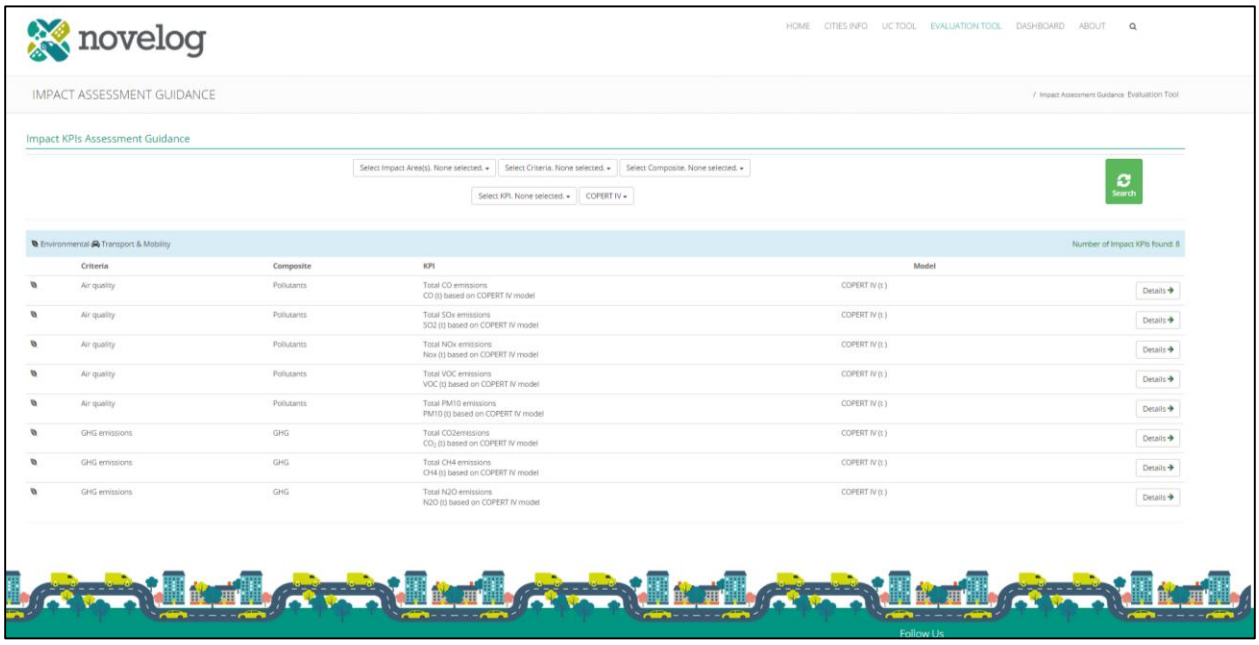


Figure 4.31: Providing list of indicators that could be measured by the selected enabling model/tool

To view further details about a specific indicator and its model/methodology, the user may click the *"Details"* button on the right side of the desired result. The details of any indicator include information related to (Figure 4.32):

- A full description the Model/Methodology used for the calculation/estimation of the indicator
- Guidance on how to use the model/methodology and, also how to convert the indicator units provided by the model/methodology to the units required by the NOVELOG Evaluation Framework
- Relative references.

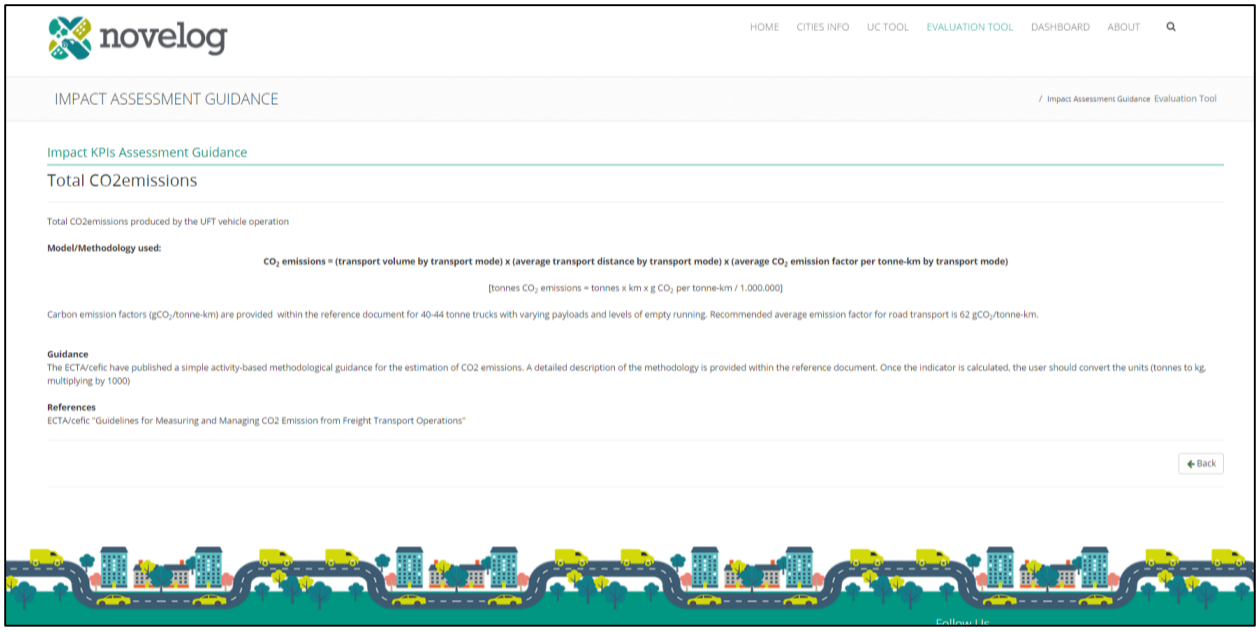


Figure 4.32 Example of the details provided for CO_2 indicator

4.5. Social Cost Benefit Analysis Module

4.5.1 Input data

The evaluation process starts with section “City description” (Figure 4.33). The mandatory fields of data that the user has to enter are the following:

- Country (chosen from the drop-down list),
- GDP for the present country for 2010,
- GDP for the EU for 2010,
- GDP for the present country for 2015,
- Time of investment realization (the construction of the project) in years,
- The project life: operation and maintenance in years.

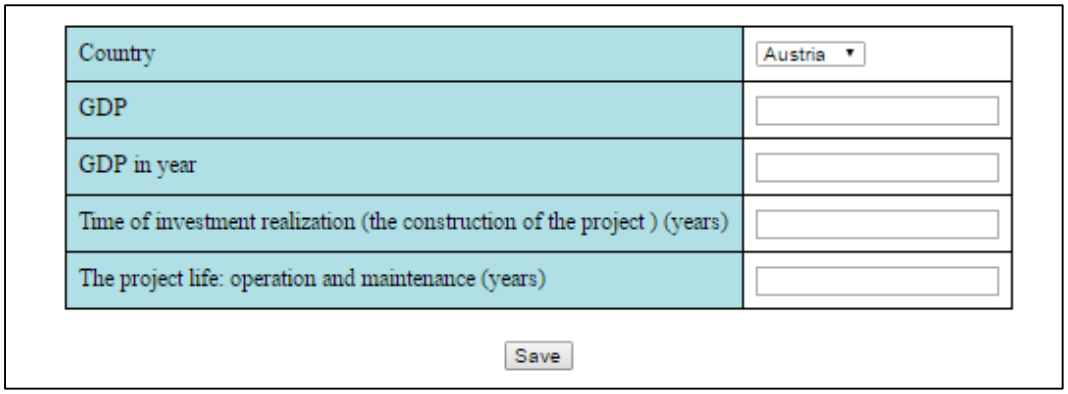
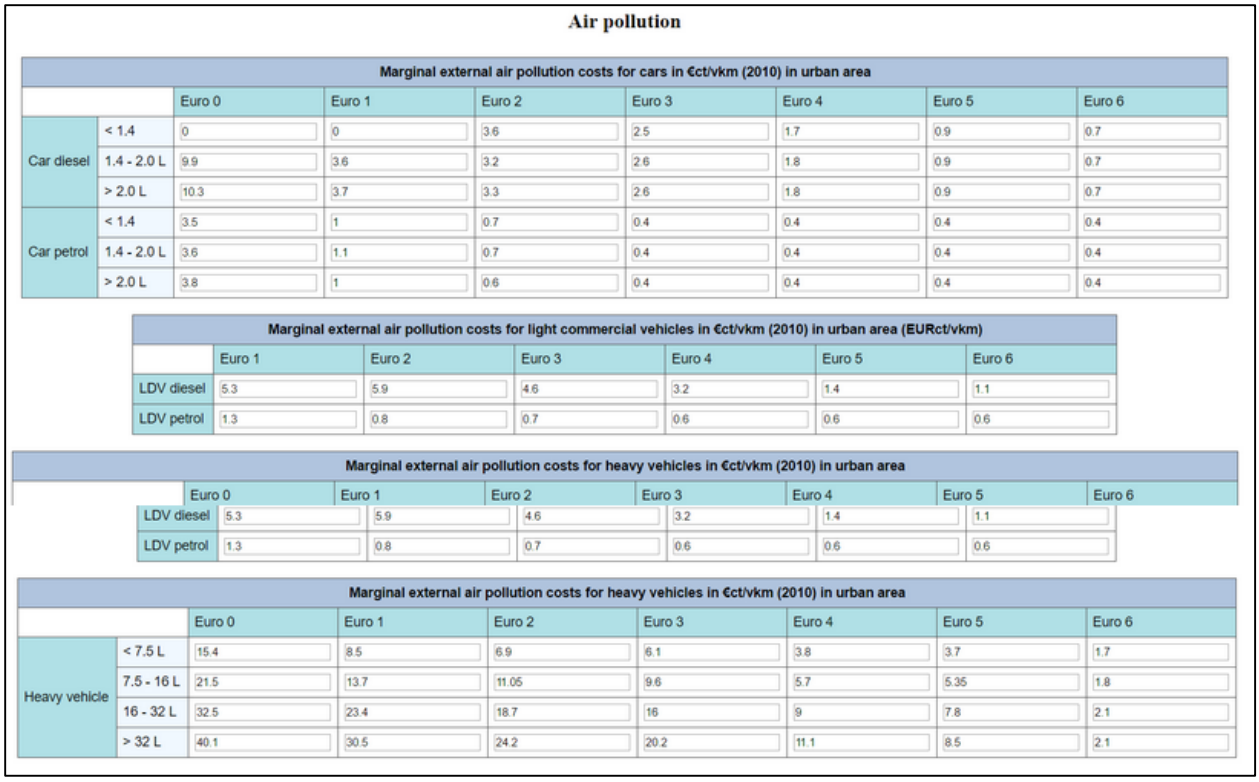


Figure 4.33 City description data window

The user should click on the “Save” button to input the data to the database.

In the next step, the user is able to change the parameters for SCBA calculation (or keep the default). For the air pollution and climate change analysis the data include (Figure 4.34):

- Marginal external air pollution costs for light commercial vehicles in €ct/vkm in urban area (EURct/vkm) – the exampled data for 2010 are implemented but the user is able to make the changes and corrections.
- Marginal external air pollution costs (for rigid heavy vehicles in €ct/vkm in urban area – the exampled data for 2010 are implemented but the user is able to make the changes and corrections.
- Marginal external air pollution costs for articulated heavy vehicles in €ct/vkm in urban area – the exampled data for 2010 are implemented but the user is able to make the changes and corrections.
- Marginal external air pollution costs for cars in €ct/vkm in urban area – the exampled data for 2010 are implemented but the user is able to make the changes and corrections.



Air pollution

Marginal external air pollution costs for cars in €ct/vkm (2010) in urban area

		Euro 0	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6
Car diesel	< 1.4	0	0	3.6	2.5	1.7	0.9	0.7
	1.4 - 2.0 L	9.9	3.6	3.2	2.6	1.8	0.9	0.7
	> 2.0 L	10.3	3.7	3.3	2.6	1.8	0.9	0.7
Car petrol	< 1.4	3.5	1	0.7	0.4	0.4	0.4	0.4
	1.4 - 2.0 L	3.6	1.1	0.7	0.4	0.4	0.4	0.4
	> 2.0 L	3.8	1	0.6	0.4	0.4	0.4	0.4

Marginal external air pollution costs for light commercial vehicles in €ct/vkm (2010) in urban area (EURct/vkm)

	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6
LDV diesel	5.3	5.9	4.6	3.2	1.4	1.1
LDV petrol	1.3	0.8	0.7	0.6	0.6	0.6

Marginal external air pollution costs for heavy vehicles in €ct/vkm (2010) in urban area

	Euro 0	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6
LDV diesel	5.3	5.9	4.6	3.2	1.4	1.1	
LDV petrol	1.3	0.8	0.7	0.6	0.6	0.6	

Marginal external air pollution costs for heavy vehicles in €ct/vkm (2010) in urban area

		Euro 0	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6
Heavy vehicle	< 7.5 L	15.4	8.5	6.9	6.1	3.8	3.7	1.7
	7.5 - 16 L	21.5	13.7	11.05	9.6	5.7	5.35	1.8
	16 - 32 L	32.5	23.4	18.7	16	9	7.8	2.1
	> 32 L	40.1	30.5	24.2	20.2	11.1	8.5	2.1

Figure 4.34 Air pollution and climate change parameters windows

For the noise analysis – The Marginal external noise costs (€ per 1000 vkm) are implemented in the module but the user has the option to change any of the default values (Figure 4.35).

Marginal external noise costs (€ per 1000 vkm)

	Day - dense	Day - thin	Night - dense	Night - thin
Noise	8.8	21.4	16.1	38.9
	44	107	80.3	194.7
	81	196.6	147.8	358

Figure 4.35 Noise analysis parameters

For the employment and development as well as the accidents analysis:

- Gross domestic product on employee total and in transport sector (€/person) for the present country – the data for all European countries for 2010 and 2015 are implemented but the user is able to make the changes and corrections.
- Climate change costs for cars and LDV – the exampled data are implemented but the user is able to make the changes and corrections.
- Efficient Marginal Congestion Costs in €ct per vkm – the exampled data for 2010 are implemented but the user is able to make the changes and corrections.
- Marginal accident cost estimates in €ct/vkm for the present country the data for all European countries for 2010 are implemented but the user is able to make the changes and corrections.

In the next step, the user may insert data for the analysis of both scenarios – before the measure implementation and after the measure implementation. The congestion data for cars, Van (LDV) and heavy vehicles are inserted in two separate tables for each scenario (Figure 4.36).

Vehicle	Region	Road type	Free flow		Near capacity		Over capacity	
			No. Of vehicles (daily)	Average distance of vehicle (daily)	No. Of vehicles (daily)	Average distance of vehicle (daily)	No. Of vehicles (daily)	Average distance of vehicle (daily)
car	Metropolitan	Motorway	13	4	0	0	0	0
		Main roads	0	0	0	0	0	0
		Other roads	2	1.1	0	0	0	0
	Urban	Main roads	0	0	0	0	0	0
		Other roads	0	0	0	0	0	0
Van(LDV)	Metropolitan	Motorway	1	3	0	0	0	0
		Main roads	0	0	0	0	0	0
		Other roads	0	0	0	0	0	0
	Urban	Main roads	0	0	0	0	0	0
		Other roads	0	0	0	0	2	1.5
Heavy vehicle (truck)	Metropolitan	Motorway	0	0	0	0	0	0
		Main roads	0	0	0	0	0	0
		Other roads	0	0	0	0	0	0
	Urban	Main roads	0	0	0	0	0	0
		Other roads	0	0	0	0	0	0

Figure 4.36 Traffic congestion data for a scenario

The air pollution/climate change data are inserted in three tables per scenario (Figure 4.37). For each table the user chooses from the drop-down lists the vehicle engine type, load capacity, EURO class and finally by filling the text box, the percentage (%) of cars in the city area. If necessary, the user may not fill in one table; however, the sum of percentages (%) of cars has to be 100%. After filling in the values, the user should update the data in the database using the "Update" button.

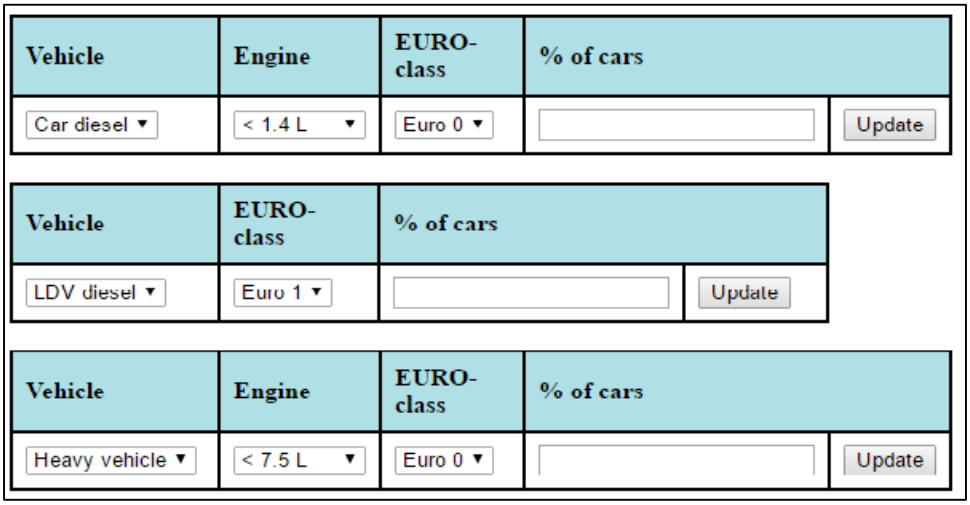


Figure 4.37 The air pollution/climate change data – share of registered cars in the city

The noise data for both scenarios “before the introduction of the measure” and “after the introduction of the measure” are based on the binary choice in two separate tables – one per each scenario (Figure 4.38).

Time of delivery	Traffic	
Day	Dense	○
	Thin	◉
Night	Dense	◉
	Thin	○

Figure 4.38 Traffic noise data

Finally, the user has to input the data for employment growth and development of local economy analysis (Figure 4.39):

- Number of direct employees (indicator: working potential),
- Number of indirect and inducted employees (indicator: business development).

Number of direct employees (KPI: workng potential)	10
Number of indirect and inducted emplyees (KPI: business development)	1

Figure 4.39 The employment growth and development of local economy data

4.5.2 Output data

The output data include benefits from reducing the external costs (Figure 4.40)

Benefits from reducing the external costs

	EU (2010)	Graz (2010)	Graz (Austria, 2015)
CONGESTION	119.355		
AIR POLLUTION	557.1725		
CLIMATE CHANGE	8642.105		
ACCIDENTS	205.3125		
NOISE	1343.03575		
EMPLOYMENT and DEVELOPMENT	703395		
TOTAL	714261.98075		

Figure 4.40 Results window for SCBA module

4.6. Transferability and Adaptability Module

4.6.1. Input data

The basis of the data input for the T/A module is the window as shown in Figure 4.41. Firstly, the user should add the stakeholder name and click on button "*Add stakeholder*". Next, the user should fill in two (for only ex-ante analysis) or three (for both ex-ante and on-going analysis) types of data per each stakeholder:

- Weights for each indicator
- Ex-ante Assessment for each indicator
- On-going Assessment for each indicator (if necessary).

Firstly, the name of chosen stakeholder is selected from the drop-down list. Secondly, the proper data type is chosen. By click on the button "*Edit*", the user is navigated to the screen with the text boxes where he/she is able to fill in the data for all indicators, that were included in analysis, by choosing the proper values from the drop-down lists (Figure 4.42).

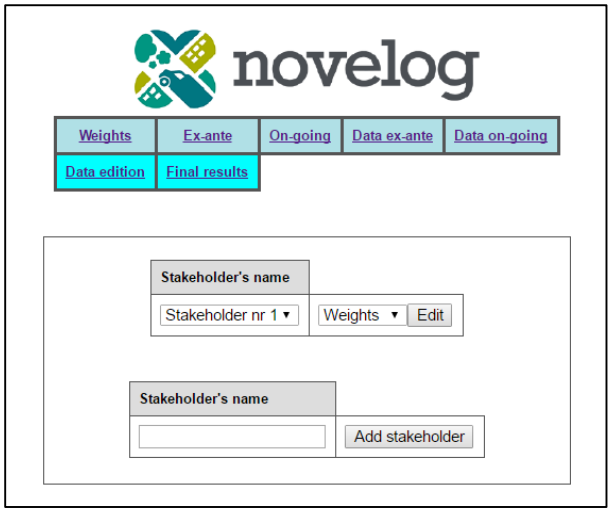


Figure 4.41 Stakeholders assessment data input – window I

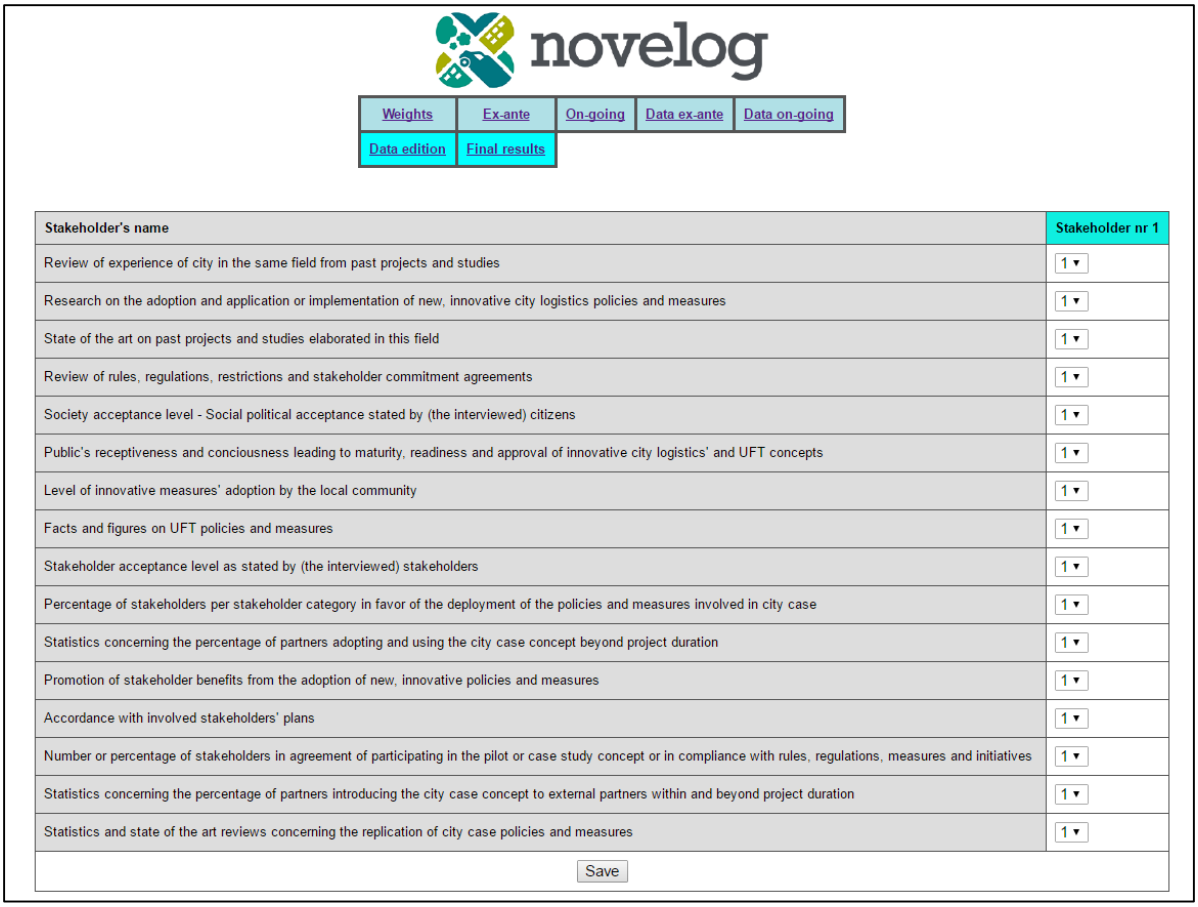


Figure 4.42 Stakeholders assessment data input – window II

The sections Weights, Ex-ante, On-going, Data ex-ante, Data ongoing are not editable and include the summaries of data as well as the partial results (example in Figure 4.43).

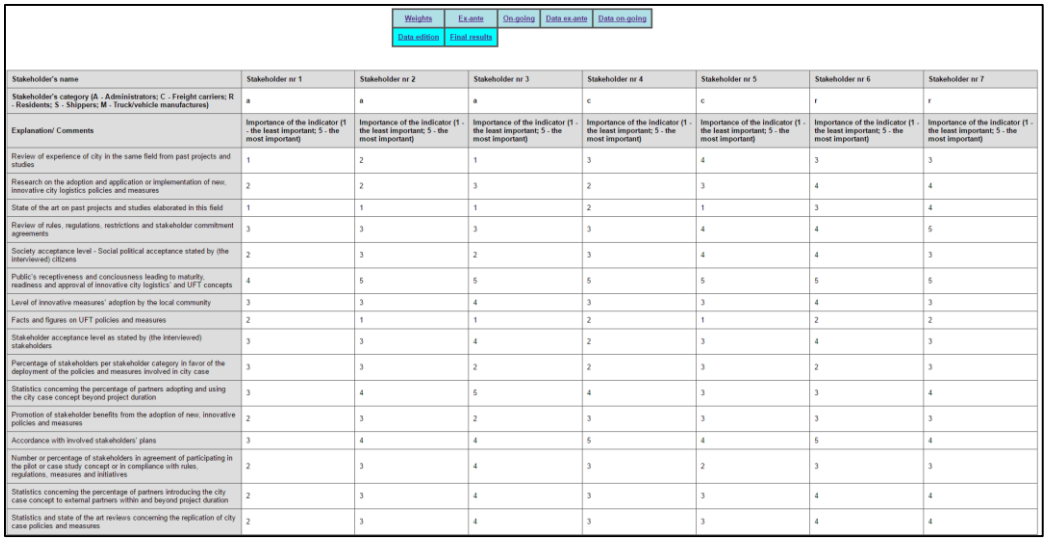
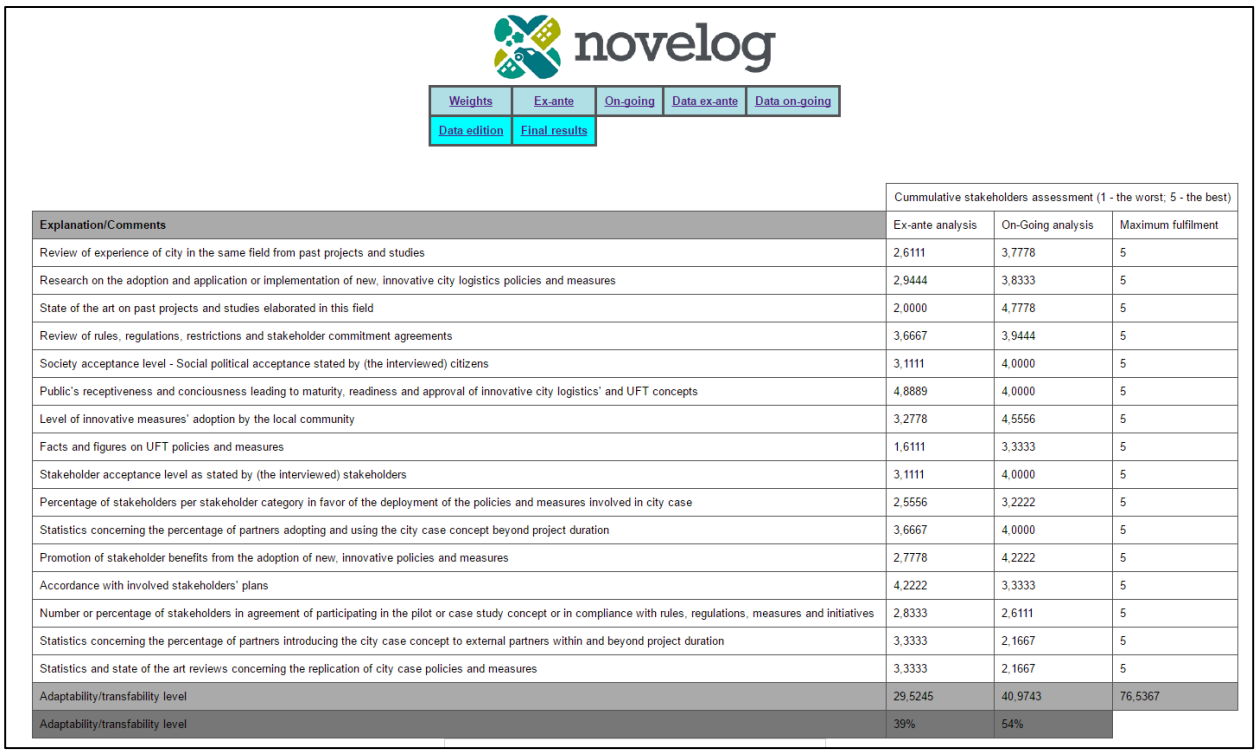


Figure 4.43 Example of not editable window

4.6.2. Output data

The output data are presented in the section “Adaptability/Transferability results” (Figure 4.44).



	Cummulative stakeholders assessment (1 - the worst; 5 - the best)		
Explanation/Comments	Ex-ante analysis	On-Going analysis	Maximum fulfilment
Review of experience of city in the same field from past projects and studies	2,6111	3,7778	5
Research on the adoption and application or implementation of new, innovative city logistics policies and measures	2,9444	3,8333	5
State of the art on past projects and studies elaborated in this field	2,0000	4,7778	5
Review of rules, regulations, restrictions and stakeholder commitment agreements	3,6667	3,9444	5
Society acceptance level - Social political acceptance stated by (the interviewed) citizens	3,1111	4,0000	5
Public's receptiveness and conciousness leading to maturity, readiness and approval of innovative city logistics' and UFT concepts	4,8889	4,0000	5
Level of innovative measures' adoption by the local community	3,2778	4,5556	5
Facts and figures on UFT policies and measures	1,6111	3,3333	5
Stakeholder acceptance level as stated by (the interviewed) stakeholders	3,1111	4,0000	5
Percentage of stakeholders per stakeholder category in favor of the deployment of the policies and measures involved in city case	2,5556	3,2222	5
Statistics concerning the percentage of partners adopting and using the city case concept beyond project duration	3,6667	4,0000	5
Promotion of stakeholder benefits from the adoption of new, innovative policies and measures	2,7778	4,2222	5
Accordance with involved stakeholders' plans	4,2222	3,3333	5
Number or percentage of stakeholders in agreement of participating in the pilot or case study concept or in compliance with rules, regulations, measures and initiatives	2,8333	2,6111	5
Statistics concerning the percentage of partners introducing the city case concept to external partners within and beyond project duration	3,3333	2,1667	5
Statistics and state of the art reviews concerning the replication of city case policies and measures	3,3333	2,1667	5
Adaptability/transfability level	29,5245	40,9743	76,5367
Adaptability/transfability level	39%	54%	

Figure 4.44 Results of the assessment

4.6.3. Graphs

The fulfillment graph is presented at Figure 4.45.

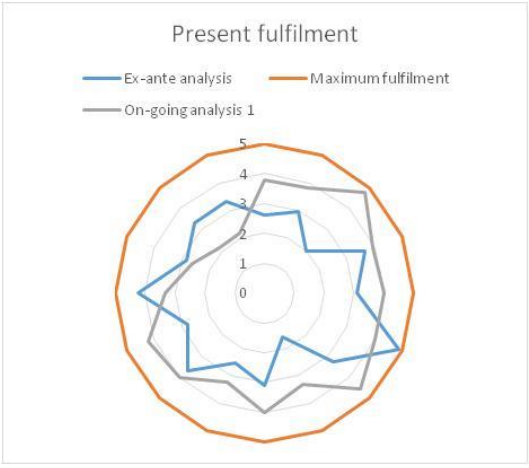


Figure 4.45 Example of fulfillment graph

4.7. Risk Analysis Module

4.7.1. Input data

The data input for the Risk assessment module is based on the separate windows for each risk category (example window for economics category is shown in Figure 4.46). The user should insert two types of data for each risk factor, using the scale 1 to 5 (if the risk factor is not selected for particular measure the cell should be empty):

- Impact value,
- Probability value.

The user is able to use the drop-down lists with the description of each chosen value for each risk factor.

Risk	Impact	Probability
Tax changes	Tax changes can influence t	35% up to 65 % chance of c
Inflation	Inflation can influence the bu	65% up to 90 % chance of c
Unstable economic situation of the country	Unstable economic situation	35% up to 65 % chance of c
The rising cost of fuel, machines and materials		
An increase in payrolls and tax payments in transportation sector in the region	An increase in payrolls and t	35% up to 65 % chance of c
Reduction of the projected capacity of freight transport system in a city	Reductionof the projected ca	Reductionof the projected ca

Figure 4.46 Example of data input window for risk assessment

4.7.2. Output data

The output includes:

- Risk severity index for each risk factor
- Risk severity index for composite indicators (risk categories):
  - Economics
  - Financial
  - Security
  - Availability of infrastructure and technology innovations
  - IT, infrastructure and technology risk
  - Sociopolitical index
  - Natural disasters and civil disturbances
  - Human resources
  - Marketing
  - Final user perspective
  - City authority's unpopularity
  - Lack of acceptance of decision-making.
- Colored codes for three actions:

- Risk mitigation is not required
- Optional corrective actions but monitoring required (see table with corrective actions for particular risk factor)
- Corrective actions and monitoring of risk factors required (see table with corrective actions for particular risk indicator).

The example of the results is shown in Figure 4.47. These windows are not editable.

Risk	Risk severity index for each risk indicator
Tax changes	3
Inflation	6
Unstable economic situation of the country	7
The rising cost of fuel, machines and materials	0
An increase in payrolls and tax payments in transportation sector in the region	11
Reduction of the projected capacity of freight transport system in a city	7
Risk Severity Index (RSIj) for risk category: economics	**5.6666666666667**

Figure 4.47 Example of the results window for risk assessment

The risk severity index for all risk categories (composite indicator) is shown in a separate row (Figure 4.48).

Risk severity index for all risk categories (composite indicators)	3.2710622710623

Figure 4.48 Final results for risk analysis

4.8. Behavioral Modeling

Behavioral Modeling (BM) enables to indicate stakeholders' attitudes towards the implementation of a sustainable measure, e.g. eco-driving or the degree of their compliance to regulations and incentives, and to capture what caused or motivated their attitudes and any behavioral changes before and after the measure's implementation. Behavioral changes analysis is being conducted by the user, independently of the Evaluation Tool, based, however, on the values collected in the Tool's database. The user may set the tests to be run, or can follow the guidance provided in the document D3.2 "Evaluation Tool" (NOVELOG, 2016e).

The user may also choose to run:

- Agent-Based Models (ABM)
- The Transtheoretical Model of Change (TMC)

In this case, the Evaluation Tool helps the user to define additional information, required by the models.

4.8.1. Input data

BM is incorporated into the multi-stakeholder multi-criteria decision making process, and is structured in twelve specific indicators (Table 4.3). In order to apply BM, the user needs to select at least one of these indicators, when setting up the evaluation.

Behavioral indicators are included in three out of the seven impact areas, namely: 1) Society, 2) Policy and Measure, and 3) Social Acceptance. The indicators per impact area, criterion and composite indicator are presented in Table 4.3.

Table 4.3 Behavioral indicators

No.	Impact Area	Criterion	Composite indicator	Indicator
1	Society	Greening	-	Green reputation
2			-	Green concern
3		Convenience	-	Perceived visual and audio nuisance
4			-	Diffusion of information
5		Living standards	-	Perceived alternative mobility
6			-	Quality of life
7	Policy and measure maturity	Awareness	-	Awareness level
8	Social acceptance	Regulations' acceptance	-	Compliance with regulations
9			-	Enforcement
10			Eco-driving	Eco-driving practice before the journey
11				Eco-driving during the journey
12				Motivation for eco-driving

4.8.1.1 Agent-Based Models

ABMs need the following entities: one or more types of agents, the environment in which the agents live and interact, which is often sub-divided into local units or patches, and the "global" environment in which all agents are embedded.

The model entities are characterized by their *state variables*, which is how the model specifies their state at any time. An agent's state is defined by its *properties*, or *attributes* (like, for example, size, age, amount of resources, preference, memory), and often by its behavioral strategy (e.g., searching behavior, bidding strategy, learning algorithm). The attributes are formed by input information that is inserted into the model. If this information is homogeneous for all the agents, it is inserted directly into the model code. If it is heterogeneous, the code can "import" the high amount of data from external files.

Information is required about the environmental structure, the actors' main features and their relationships. According to the output desired, the user can use as input some or all indicators listed in Table 4.3. In addition, input about the stakeholders' initial attitudes is needed. Indicative questionnaires, which allow gathering such information, may be found in the document D3.2 "Evaluation Tool" (NOVELOG, 2016e).

Lastly, the user gives values to the state variables before and after the measure implementation, enabling the comparison of the two scenarios.

4.8.1.2 Transtheoretical Model of Change

The Transtheoretical Model of Change (TMC) applies only to the first four indicators belonging to the criterion "regulations' acceptance" (Table 4.3). When the user chooses one of these indicators, he/she has to give values on a Likert scale, related to the frequency of the indicator adoption. In parallel, the user is prompt to choose one of the statements, also related to the indicator, which represents his/her attitudes towards compliance with regulations, enforcement and eco-driving (Figure 4.49). This process is required both before and after the measure implementation.

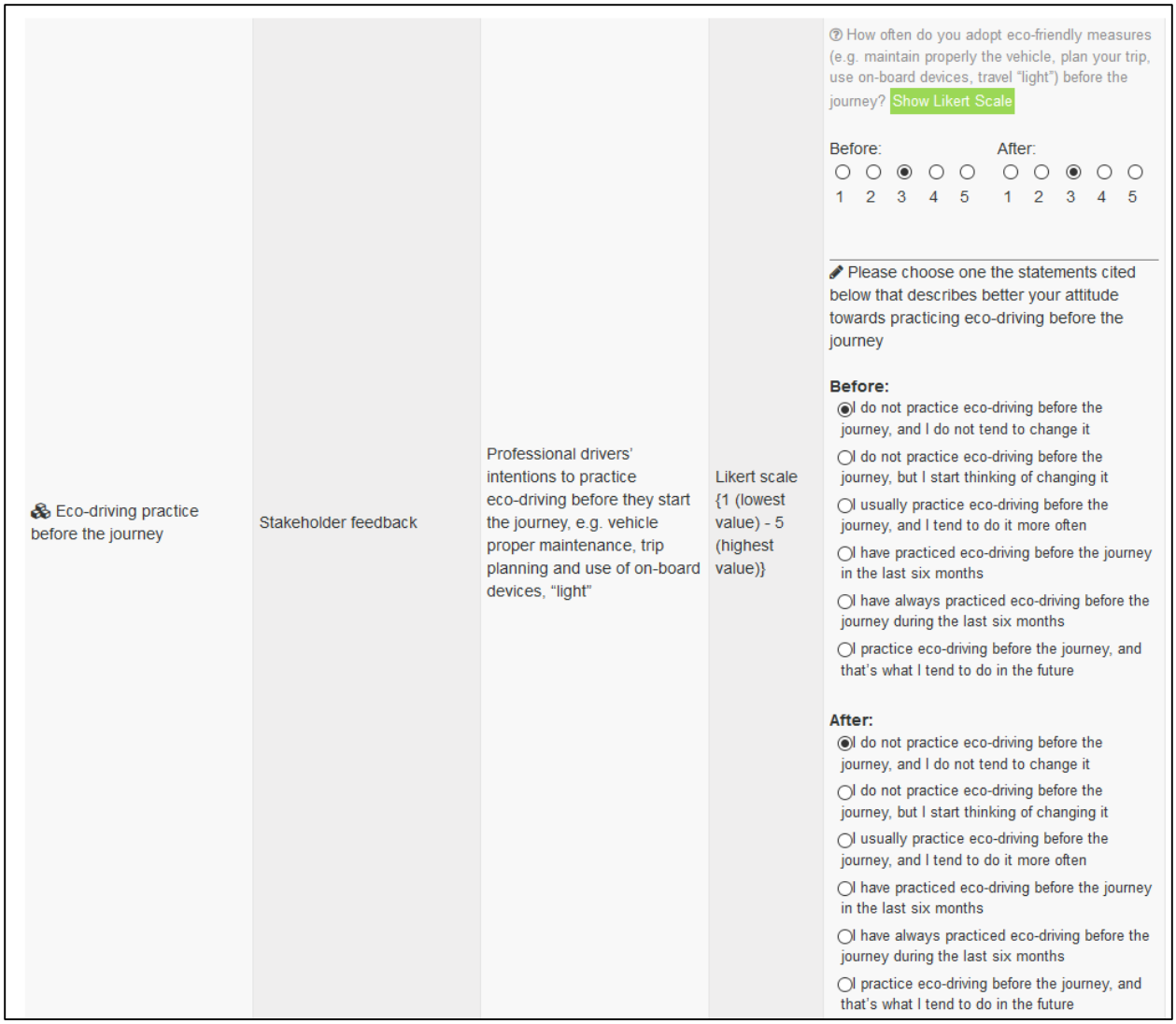


Figure 4.49 Implementing TMC

4.8.2. Output data

4.8.2.1 Agent-Based Models

The main outputs of ABM, which enable the assessment of stakeholders' specific reactions and the success of the UFT measures (e.g. policies), are the following:

- Percentage of stakeholders (agents) shifting their behavior towards more eco-friendly alternatives
- Variation in the number of vehicle travelled kilometers and variation of the average speed of trucks (measured in km/hour)
- Difference in the levels of emissions and congestion before and after the measure implementation.

Comparing the values of the respective variables before and after the measure implementation, it can be estimated to what extent the measure was successful in generating a behavioral change of the involved stakeholders.

4.8.2.2 Transtheoretical Model of Change

TMC allows defining the degree of behavior change, through the comparison of the “before” and “after” selection of the respective statement for the four BM indicators, shown above. Useful conclusions can be drawn, addressing for example the proportion of those stakeholders who have repudiated their previous behavior and have established a new behavior towards complying with regulations, enforcement, and eco-driving practice before and during the journey.

4.8.3. Graphs

Indicative output layout of ABM, is presented and discussed through an example. Let’s consider a model in which agents represent retailers who must choose, either to use an Urban Distribution Center (UDC) or not. We assume that the use of UDC produces a decrease of the costs for the vehicles, since it allows to use time resources in a more efficient way. In the “starting” scenario public policies do not provide incentives for an intensive use of the UDC, therefore the number of vehicles choosing this option is low (Figure 4.50). As a consequence the vehicles not using UDC have a low loading factor and in total we will have a higher number of vehicles in circulation. The level of polluting emission is high. In the “after-policy” scenario we assume that public policies actively create conditions for which the use of the UDC is convenient, therefore the number of vehicles choosing this option increases and each of them will have a higher loading factor (Figure 4.50). In total we will observe a lower number of circulating vehicles and the level of polluting emissions decreases.

The two sliders “vh-not-UDC-price” and “vh-UDC-price” indicate the costs that vehicles must bear. The two sliders “uncertainty-tolerance” and “min-satisfaction” are linked to the decision-making process of the agents. The first indicates the tolerance towards high or low levels of uncertainty, while the second indicates the minimum level of satisfaction accepted by an agent. When this level is reached, the agent has an incentive to change his/her behavior. The whole decision making process is a complex mechanism written in the code of the model. Agents basically may choose either to take the cheapest option or to imitate the members of their social network. Agents build links with 5 other agents having similar starting attitudes, simulating in this way a social network . The slider “random-pos” indicates the fact that agents that do not find neighbour with similar attitudes, establish a link with 5 random agents.

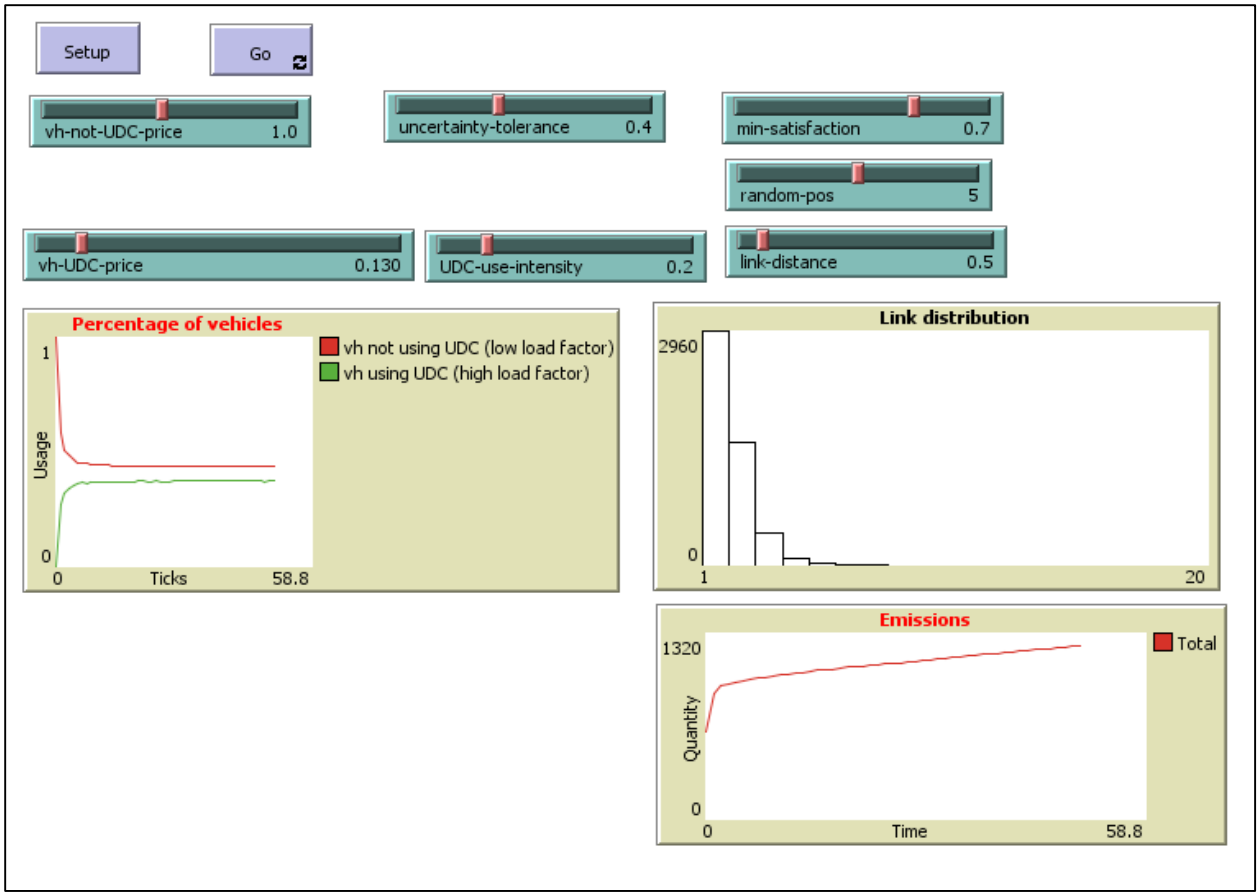


Figure 4.50 Simulation of the starting scenario (UDC use intensity = low, Vh = vehicles)

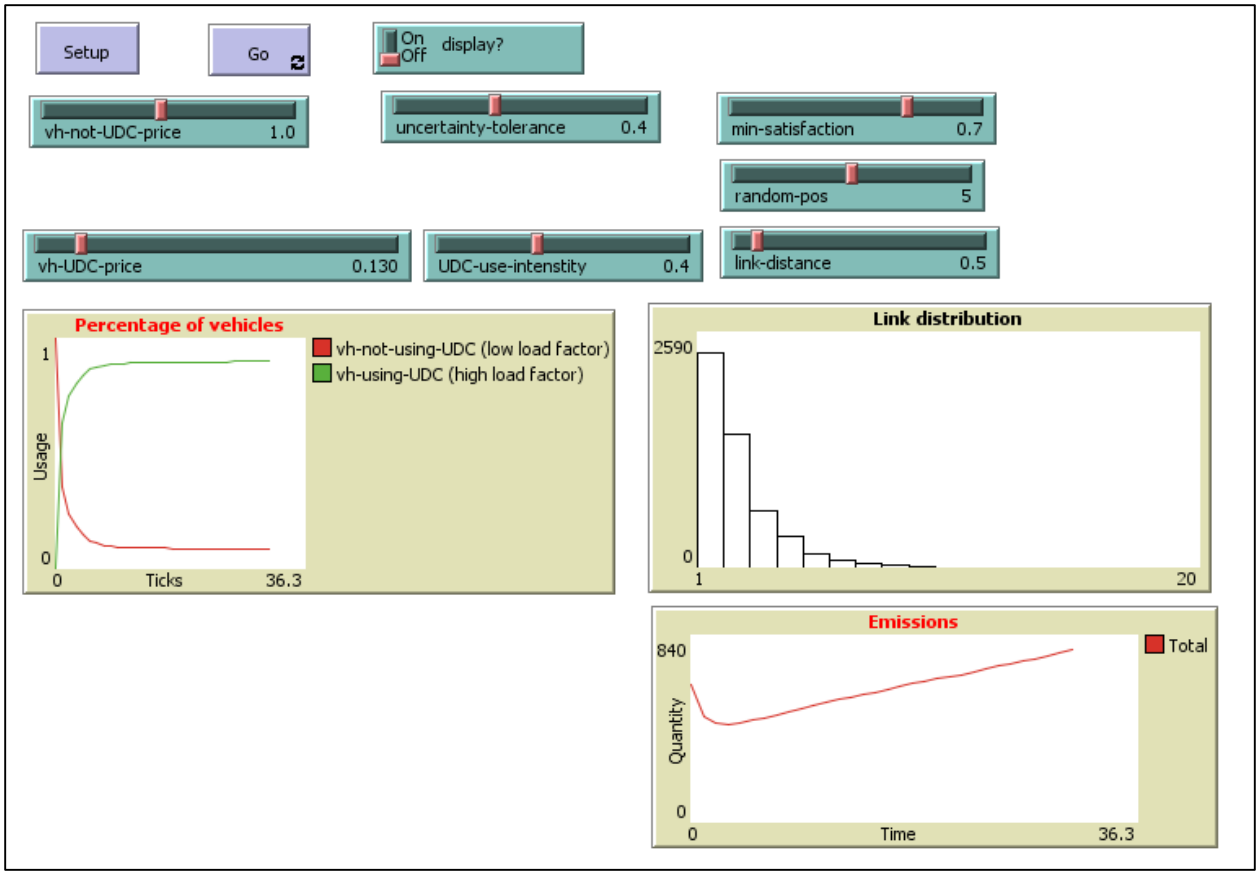


Figure 4.51 Simulation of the after-policy scenario (UDC use intensity = high, Vh = vehicles)

5. Reporting

Once a case study has been completed, the user can view the respective reports, generated by the Evaluation Tool. The reports may be generated by clicking on *"Select"* for the desired case study in the page "History" (Figure 5.1).

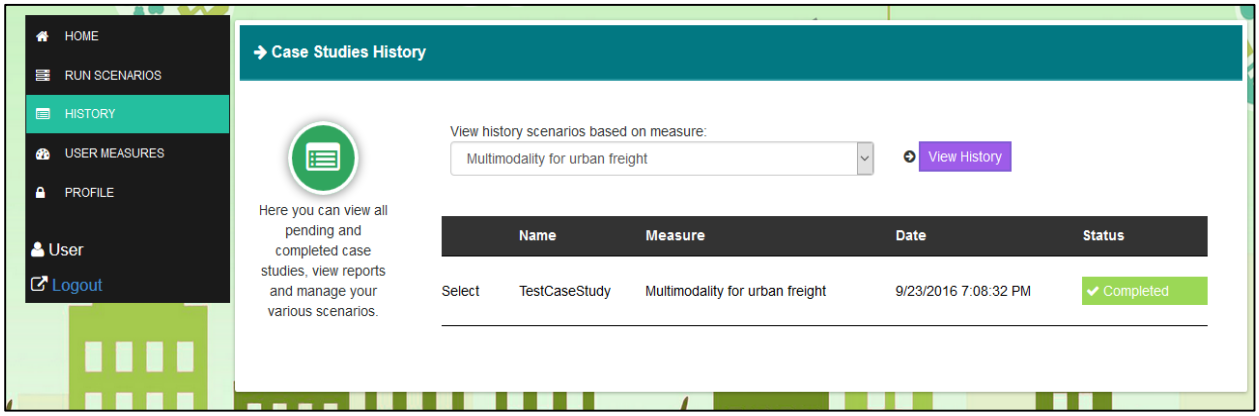


Figure 5.1 Case studies history page (summary)

The "case studies history" page (Figure 5.2) provides an overview of the tested case study, including:

- Case study name
- Comments
- User name
- City
- Stakeholder category
- Measure
- Objectives (primary and secondary)
- Lifecycle stages.

The user is possible to:

- View reports
- Create scenario copy
- Delete the specific scenario.

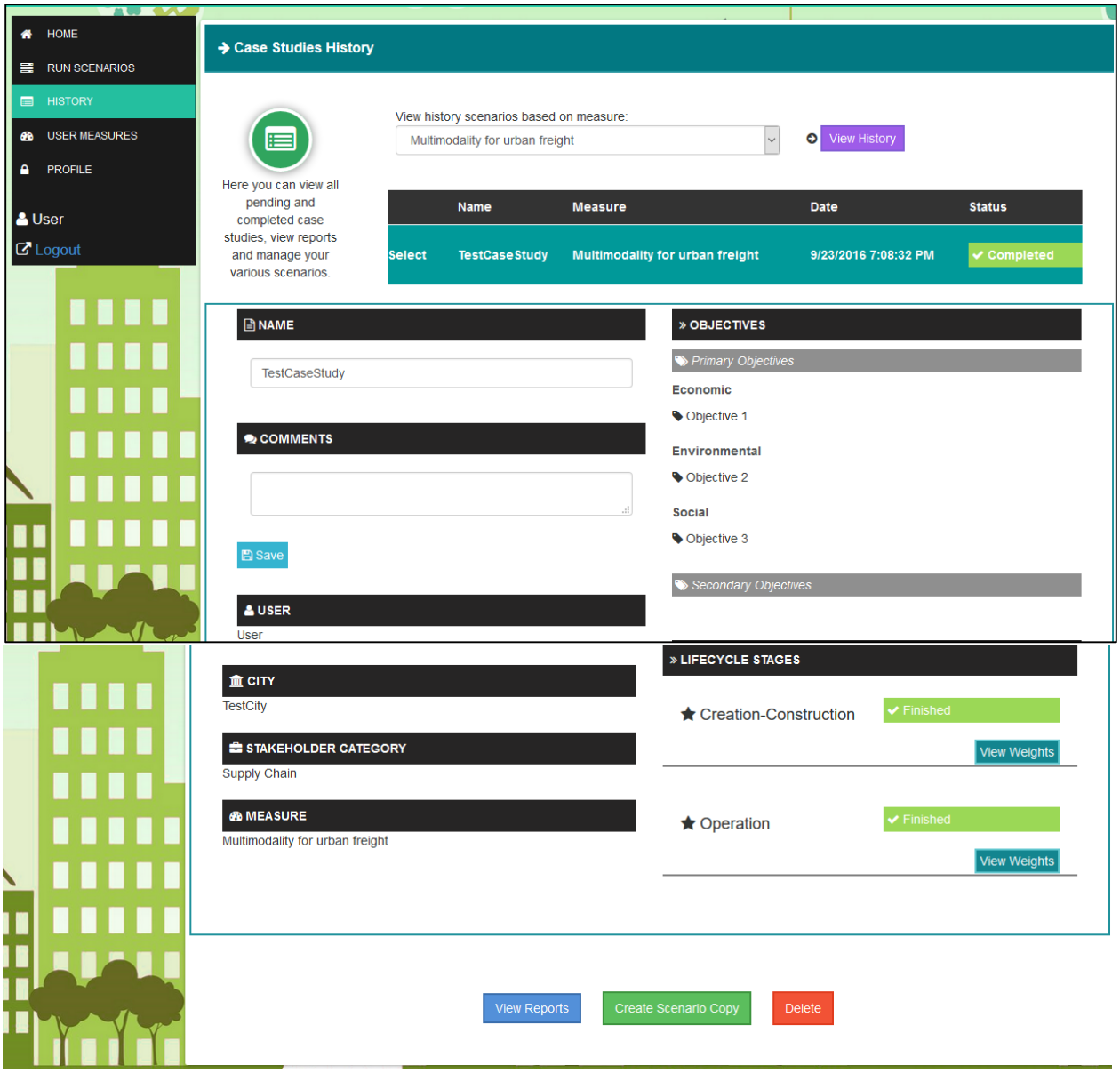


Figure 5.2 Case studies history page (overview)

By pressing the button “View reports”, the user can view generated reports for selected lifecycle stages (Figure 5.3), the lifecycle index per impact area (LCI) (Figure 5.4), and the stored values of the indicators per lifecycle stage (Figure 5.5).

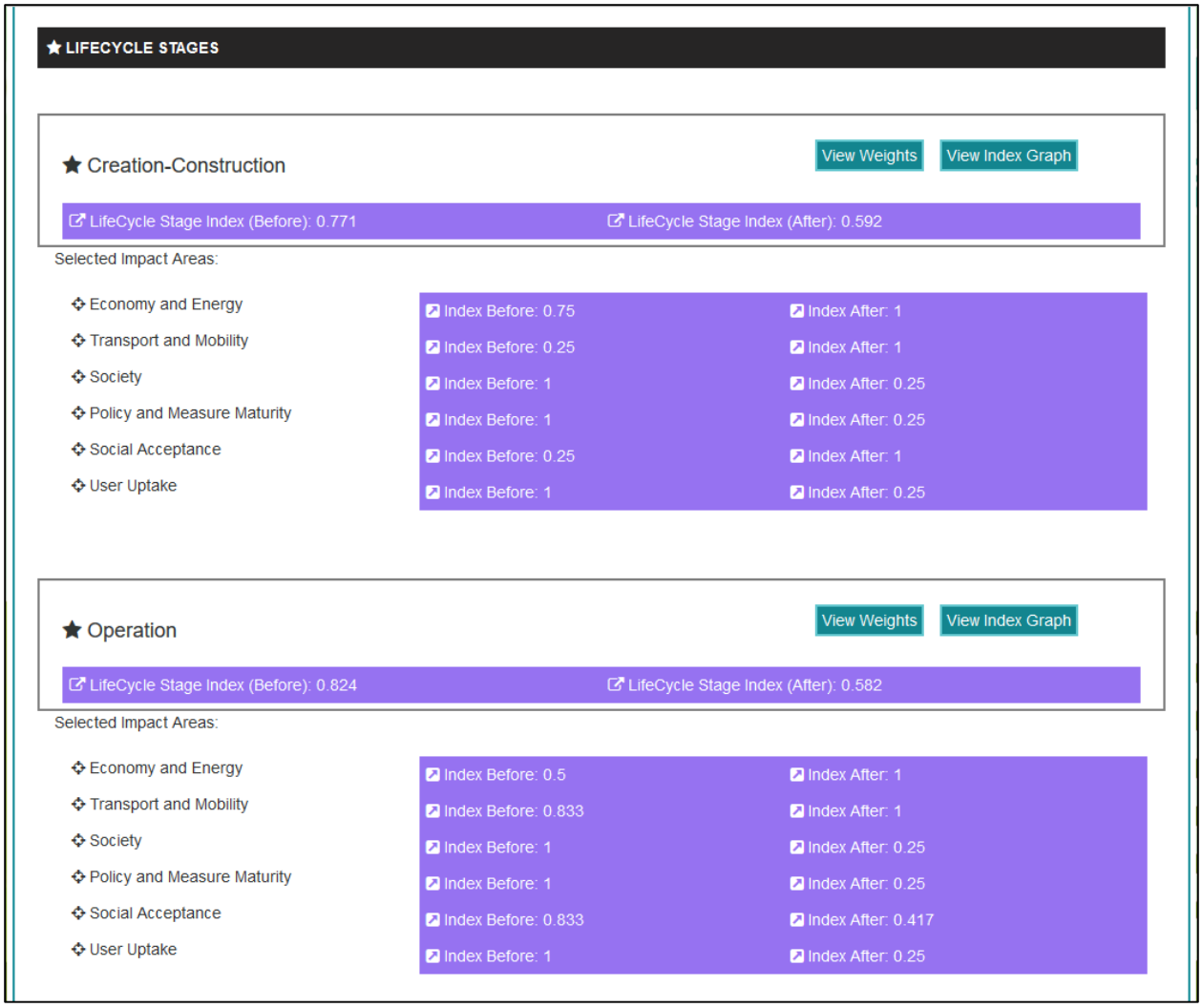


Figure 5.3 Lifecycle stages reporting

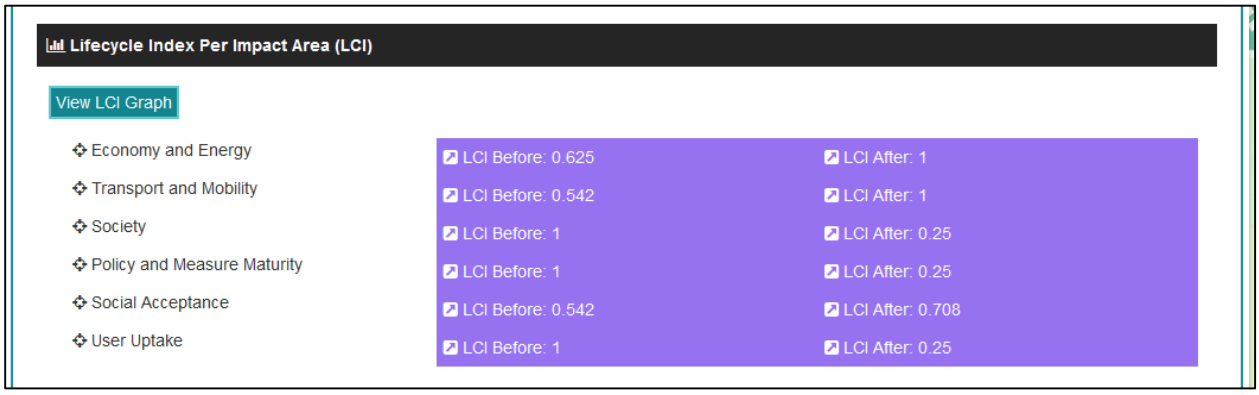


Figure 5.4 Lifecycle index (LCI) per impact area

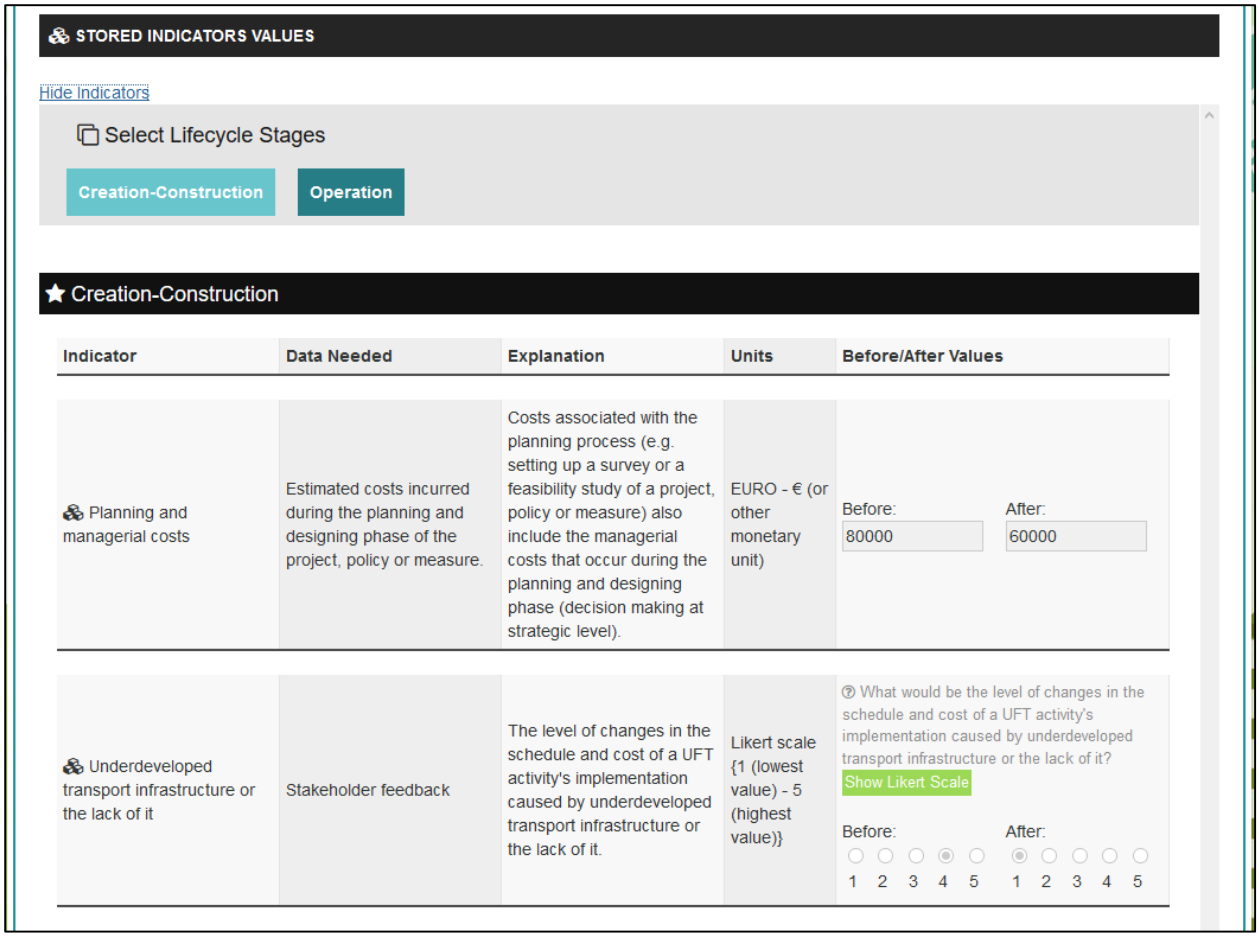


Figure 5.5 Stored indicator values

As it is shown in Figure 5.3, the user can view the total lifecycle stage index for each of the lifecycles stages he/she has tested, as well as the individual index for each of the selected impact areas, before and after the measure implementation. By pressing “View Weights”, the final generated weights for the scenario components (impact areas, criteria, indicators) and the consistency ratio, are presented (Figure 5.6). These results can be also exported to an “Excel” file (Figure 5.7).

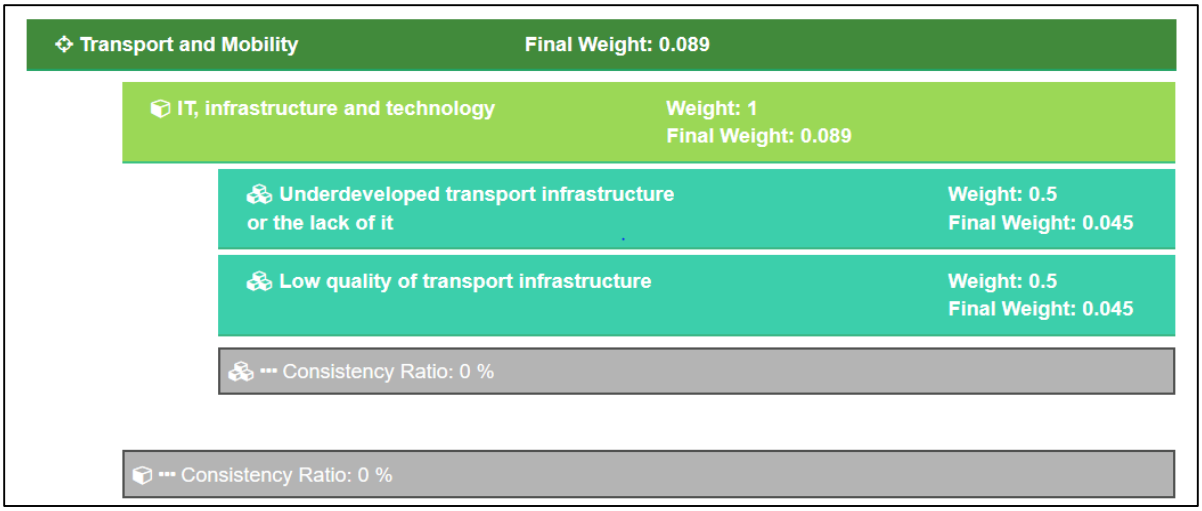


Figure 5.6 Weights

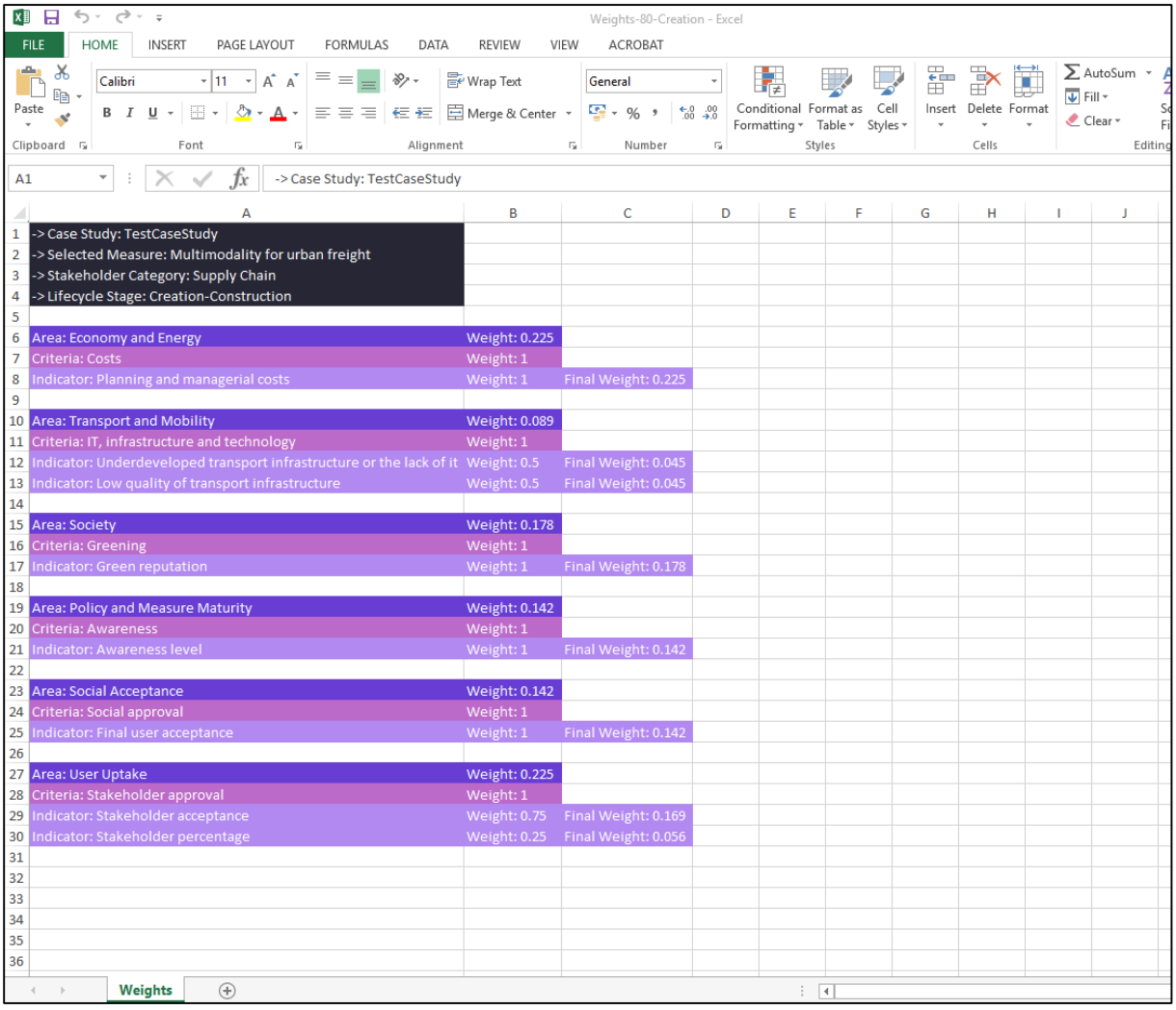
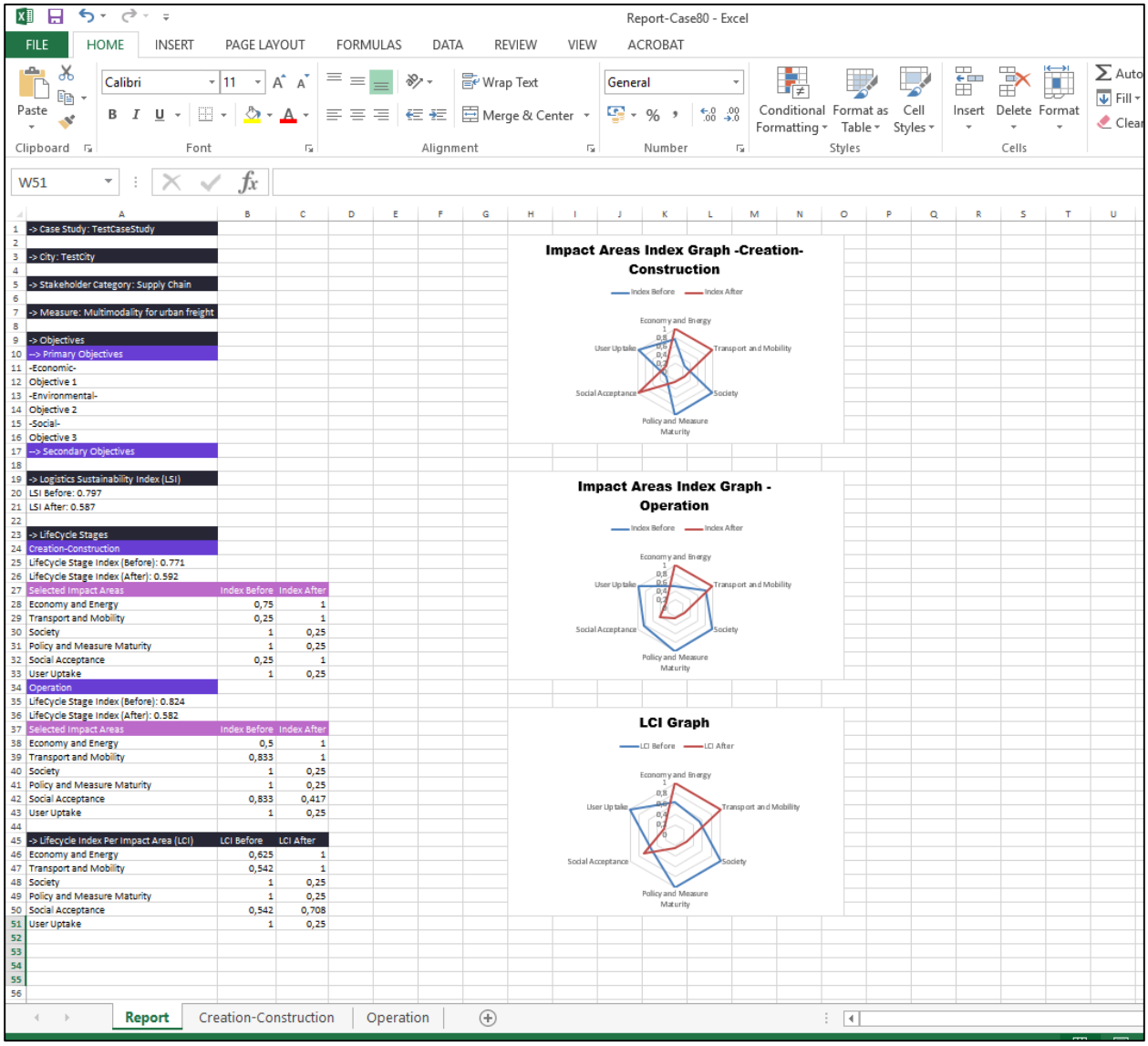


Figure 5.7 Exporting of weights in excel file

Lastly, the user has the option to export in an Excel file, a full report of the case study he/she has tested. The first sheet of this report, named “Report” gives an overview of the results of the whole scenario (Figure 5.8), and additional sheets are generated for each lifecycle stage, including the values of the tested indicators, before and after the measure implementation (Figure 5.9).



	A	B	C
1	-> Case Study: TestCaseStudy		
2			
3	-> City: TestCity		
4			
5	-> Stakeholder Category: Supply Chain		
6			
7	-> Measure: Multimodality for urban freight		
8			
9	-> Objectives		
10	--> Primary Objectives		
11	-Economic-		
12	Objective 1		
13	-Environmental-		
14	Objective 2		
15	-Social-		
16	Objective 3		
17	--> Secondary Objectives		
18			
19	-> Logistics Sustainability Index (LSI)		
20	LSI Before: 0.797		
21	LSI After: 0.587		
22			
23	-> LifeCycle Stages		
24	Creation-Construction		
25	LifeCycle Stage Index (Before): 0.771		
26	LifeCycle Stage Index (After): 0.592		
27	Selected Impact Areas	Index Before	Index After
28	Economy and Energy	0,75	1
29	Transport and Mobility	0,25	1
30	Society	1	0,25
31	Policy and Measure Maturity	1	0,25
32	Social Acceptance	0,25	1
33	User Uptake	1	0,25
34	Operation		
35	LifeCycle Stage Index (Before): 0.824		
36	LifeCycle Stage Index (After): 0.582		
37	Selected Impact Areas	Index Before	Index After
38	Economy and Energy	0,5	1
39	Transport and Mobility	0,833	1
40	Society	1	0,25
41	Policy and Measure Maturity	1	0,25
42	Social Acceptance	0,833	0,417
43	User Uptake	1	0,25
44			
45	-> Lifecycle Index Per Impact Area (LCI)	LCI Before	LCI After
46	Economy and Energy	0,625	1
47	Transport and Mobility	0,542	1
48	Society	1	0,25
49	Policy and Measure Maturity	1	0,25
50	Social Acceptance	0,542	0,708
51	User Uptake	1	0,25

Figure 5.8 Export of full report in excel file

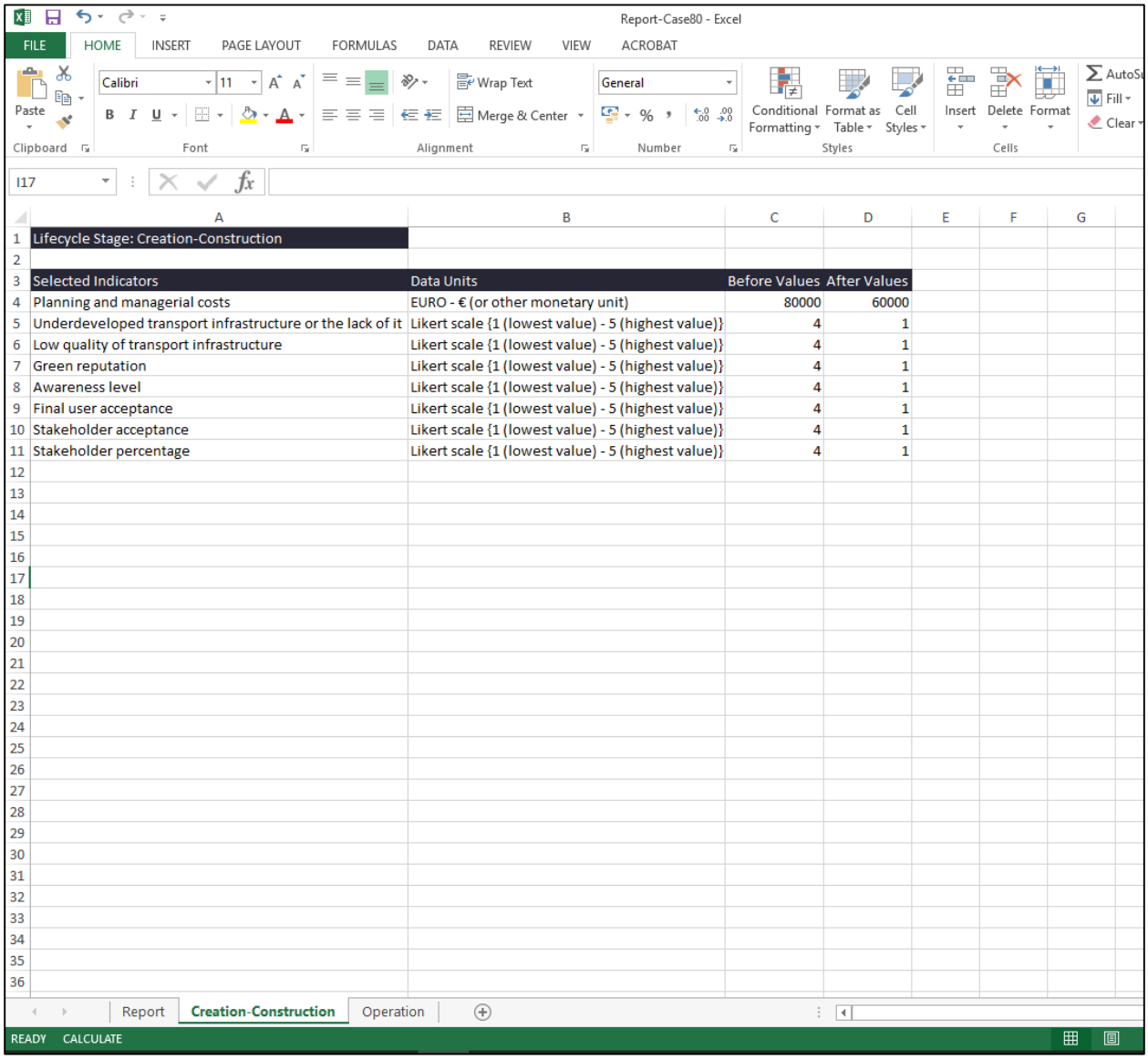


Figure 5.9 Export of results per lifecycle stage in excel file

6. Software Development

The system requirements of efficient software are defined to be all the necessary hardware components as well as all other software resources to be present on a computer for the implementation and the execution of the original software. These prerequisites are often used as a guideline mostly for recommendation as opposed to an absolute rule especially for the hardware part of the requirements. In practice all software defines two sets of system requirements: minimum and recommended. However, as it always happens with the increasing demand for higher processing power and resources in newer versions of software usually, system requirements tend to increase over time. The aforementioned software tool integrates web technologies (web services, n-tier architecture, client and server side programming, information services and a complex forecasting algorithm for division of measures, criteria and several assessment mechanisms for the calculation of LCI's and LSI's) into a single web-based application that is user friendly and has the ability to manage and depict all necessary functionalities. In this manuscript we present the set of software libraries and external or third party components needed for the development, installation and execution of this web application as well as the hardware components needed for the hosting of this web application.

6.1. Software Requirements

The system is developed ASP.NET, HTML and in JavaScript programming language using the Microsoft's ASP.NET Framework 4. The development of most of the classes for the object oriented programming for the back-end of the system was done using the C# programming language. This environment has been proven to be a rather very secure environment with the help of the windows authentication mechanisms in order to avoid security holes. This evaluation tool has been built as a web application which can be accessed by any web browser.

For the communication between the front-end of the application and the database (creation, saving and updates of scenarios) the Language Integrated Query (LINQ) is used. LINQ is a set of features that extends powerful query capabilities to the language syntax of C#. Furthermore, LINQ introduces various standard, easily-learned patterns for querying and updating data, and this technology can be extended to support potentially any kind of data store. The .NET Framework includes all the necessary LINQ provider assemblies that enable the use of LINQ with .NET Framework collections, SQL Server databases, ADO.NET Datasets, and XML documents. For the design and the integration of the database into the web application, the MSSQL 2012 database management system was used. This database management tool is the most popular tool for the creation and administration of multiple databases that can be supported by a web application and it works tightly with the IIS host where the system resides. Note that the version of the database server maybe of previous version since there is absolute compatibility between versions.

Also asynchronous JavaScript and XML or AJAX for short is a set of web development techniques which was used for this type of client-side asynchronous web applications. With AJAX, web applications can send data to and retrieve from a server asynchronously (in the background) without interfering with the display and behavior of the existing page. By decoupling the data interchange layer from the presentation layer, Ajax allows for web pages, and by extension web applications, to change content dynamically without the need to reload the entire page.

HTML and Cascaded Style Sheets (CSS) are required for the front-end design of the application. HTML is the well-known basic tag-language used for rendering web pages. On the other hand CSS is a style sheet language used for describing the presentation of a document written in a

markup language. Although most often used to set the visual style of web pages and user interfaces written in HTML, the language can be applied to any XML document, and is applicable to rendering in speech, or on other media. Along with HTML and JavaScript, CSS is a cornerstone technology used by most websites to create visually engaging webpages, user interfaces for web applications, and user interfaces for many mobile applications but is basically designed to primarily enable the separation of document content from document presentation, including aspects such as the layout, colors, and fonts. Therefore it is absolutely required for such web applications as the vast majority of any web content.

Finally a good amount of the client-side coding requires the use of JavaScript or higher-level JavaScript libraries such as JQuery. JavaScript is prototype-based with first-class functions, making it a multi-paradigm language, which supports object-oriented, imperative, and functional programming styles. It has an API for working with text, arrays, dates and regular expressions, but does not include any I/O, such as networking, storage, or graphics facilities, relying for these upon the host environment in which it is embedded.

External Component/Module Bridging
For the interoperability of the web application with all external modules which are implemented separately and not necessarily under the same programming environments mentioned above, there is a need for a set of web services to be implemented. The triggering of these services will make possible for the core evaluation tool to capture the user choices and make the appropriate calls to these external modules. For that reason an API is required for all external module developers is needed for them to use as an interface between the two.

Third Party Libraries
For the Rapid Application Development/Methodology (RAD/M), the following third party libraries or autonomous development software was used:

- *Highcharts* (Charting library for web graphs generation)
- *Newtosoft* (JavaScript Object Notation (JSON) serializer and deserializer library)
- *SpreadhseetLight* (library for EXCEL exporting functions)

Hosting Requirements
This project can be hosted on machines meeting the following requirements:

- Relatively to the Operating System : Windows Server with Internet Information Services (IIS) enabled
- Database: Microsoft SQL Express 2008 and later
- .NET framework Version 4.0 and later installed

6.2. Hardware Requirements

The application can run on an IIS Virtual Machine (VM) that is deployed in a physical server under some domain. The VM consists of the following typical properties[1]:

- Windows Server 2012 64bit with IIS
- Microsoft SQL Server 2012 Express
- Processor: Intel Xeon(R) E3 1220
- Memory: 4GB
- HDD: 500GB

[1] The above properties are typical. Certain modification and other versions can be used without any effect on the performance of the system

7. Contact and Support

For more information and support regarding the Evaluation Tool, please contact us using the details below:

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