#### (FRS) FUTURE 未来 RESILIENT 韧性 SYSTEMS 系统





## MCDA INDEX TOOL

## AN INTERACTIVE SOFTWARE TO DEVELOP INDICES AND RANKINGS

### User Manual v.1

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Yiwen Zhang<sup>1</sup>, Matteo Spada<sup>2</sup>, Marco Cinelli<sup>1,3</sup>, Wansub Kim<sup>1</sup>, Peter Burgherr<sup>2,\*</sup>

<sup>1</sup> Future Resilient Systems (FRS), Swiss Federal Institute of Technology (ETH) Zürich, Singapore-ETH Centre (SEC), Singapore

<sup>2</sup> Paul Scherrer Institut (PSI), Laboratory for Energy Systems Analysis, Villigen PSI, Switzerland

<sup>3</sup> Institute of Computing Science, Poznań University of Technology, Poznań, Poland

\*Corresponding author: email: <u>peter.burgherr@psi.ch</u>

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## 1. MCDA Index Tool General Information 1.1 Introduction

Multiple Criteria Decision Analysis (MCDA) is a process that supports decision-making by leading the identification/creation of the alternatives, the selection of the evaluation indicators and the comprehensive comparison of these alternatives (with e.g., a ranking, a classification) to work out a decision recommendation (Bouyssou et al. 2006, Cinelli 2017). It is commonly applied to support decision-making when discrete alternatives are compared with respect to multiple indicators. A main family of MCDA methods is represented by composite indicators (CI), or indices (Diaz-Balteiro et al. 2017, El Gibari et al. 2018, Greco et al. 2018), which aggregate the performance of the alternatives and the preferences of the decision makers in a single score, which can then be used to easily rank them.

Until now, there has not been any tool that can support the development of indices by constructing them in a stepwise fashion. This manual describes the *MCDA Index Tool*, which is a web tool consisting of five main steps that guide the analyst in the development of indices starting from data loading, to weighting, normalization, aggregation and ample results visualization, which aid a robustness assessment of the indices/rankings. Each component of the tool is presented in detail in this document. This web tool aims to provide a practical and straightforward guide on the selection of normalization methods and aggregation functions to obtain scores and rankings for the alternatives under interest in a graphical and printout manner. In particular, it is based on a set of steps that can help developing indices by learning and assessing the quality of the outputs. The manual shows how to use this tool to conduct a MCDA on the data under the user interests.

#### 1.2 Overall features

The tool contains 10 different features:

- 1. Input Data
- 2. Settings and Weighting
- 3. Construction of the indices
- 4. Normalization
- 5. Results: Indices and rankings
- 6. Results: Rank Frequency Matrix
- 7. Results: Scores bar charts
- 8. Results: Rankings comparisons
- 9. About
- 10. Background material.

These features are listed on the left side menu (Figure 1) and briefly described below.

📰 MCDA Index Tool	(FRS) FUTURE 未来 PAUL SCHERRER INSTITUT RESILIENT 韧性 SYSTEMS 系统 系统 系统 系统 不可以 Scherrer Institut
input data	
لَّے Settings and weighting	Future Resilient Systems (FRS) Singapore-ETH Centre ETH Zurich
E Construction of the indices	Paul Scherrer Institute
🌣 Normalization	MCDA Index Tool An interactive software to develop indices and rankings
🛱 Results: Indices and rankings	
I Results: Rank frequency matrix	Peter Burgherr (Principal Investigator FRS / Paul Scherrer Institut) Matteo Spada (Co-Principal Investigator FRS / Paul Scherrer Institut) Marco Cinelli (Postdoc FRS) Wansub Kim (Computer Scientist FRS)
<b>lll</b> Results: Scores bar charts	Yiwen Zhang (Research Assistant FRS)
Results: Rankings comparisons	peter burgherrißgesich. Start
i About	OpenShift Online Version 1.0: January 2020
📕 Background material	Aim of this tool This tool aims to provide a practical and straightforward guide for the construction of indices and rankings. In particular, it contains a set of steps that can help developing indices by learning and assessing the quality of the outputs. Suggested citation Cinelli, M., Spaka, M., Zhang, Y., Kim, W., Burgherr, P. 2018. MCDI Index Tool. An interactive software to develop indices and rankings. http://dx.doi.org/10.13140/R6.2.2.24321.71559
	Acknowledgments. The research was conducted at the Nature Resilient Systems (FRS) at the Singapore-ETH Centre (SEC), which was established collaboratively between ETH Zürich and Singapore's National Research Foundation (FI 370074011) under its C Research Causicae (vol Technological Enterprise (CREATE) program.

FIGURE 1: OVERVIEW OF THE MCDA INDEX TOOL LAYOUT

**Input data**: Here, the user can select a CSV (Comma-Separated Values) data file that contains the dataset for the analysis and upload it for later processing. The structure and format of the CSV is discussed in the next section.

**Settings and weighting**: The polarity and weight for each indicator can be assigned by the user in the setting panel. Besides this, the unit can also be added, if desired.

**Construction of the indices**: The user can select the normalization methods and aggregation functions to be used for the data processing. After confirming the choices, a combination table is shown in the same page to depict the validity of each combination method.

**Normalization**: The normalized data values are shown on the tabs for each normalization method selected in the "Construction of the indices" page. The user can skip this section and jump to the results page directly.

**Results: Indices and rankings**: This page provides the results of the valid normalization + aggregation combinations selected by the user in the "Construction of indices" page.

**Results:** Rank frequency matrix: The rank frequency matrix table is shown, with the proportion (in %) of indices which rank alternative x at the k-th position.

**Results: Scores bar charts**: After selecting the combinations of normalization + aggregation methods for comparison, the bar charts showing the normalized scores for each combination appear accordingly.

**Results: Rankings comparisons**: The line graphs of the combination normalization + aggregation for each alternative is shown. The user can select and deselect the combination(s) to be plotted in the legend.

**About**: This page shows the basic information about the tool, including the team involved in the project.

**Background materials**: The six tabs present the normalization methods and aggregation functions programmed in the tool, the valid combinations, the swing weighting method, and the reference papers.

## 2. Steps of the MCDA Index Tool

#### 2.1 Registration and Logging in

The *MCDA Index Tool* is an online tool that can be accessed at the webpage: http://www.mcdaindex.net/. In order to access the tool, a new user should register an account by clicking on "Join us"; a new window will then appear to input the requested information (i.e., name, e-mail, password) for the registration; once registered a confirmation e-mail will be send to the user. After an account has been created, the user can access the tool by logging into it (see Figure 2).

MCDA INDEX TOOL
LOG IN
Your user name
1
Your password
1
Im not a robot
LOGIN
Join us Forgot password?

FIGURE 2: MCDA INDEX TOOL LOGIN PAGE

#### 2.2 Tool interface overview

After logging in successfully, the user is redirected to the "About" page, which contains information about the tool and the developing team (see Figure 1). The user should then click on "Start" to begin using the tool.

#### 2.3 Data preparation

Once the "Start" button has been clicked, the tool redirects the user to the "Input data" page. In that page, the dataset to be analysed can be uploaded to the tool in CSV format. If the user is using MS Excel, it is highly recommended to set the data format as "General" to show all the decimals of the actual values before converting the file to CSV. Furthermore, it is important to note that the CSV should be comma-separated and thus the user needs to be sure that this is the default separation character for the operation system (e.g., Windows, Mac OS, Linux, etc.) default language. In fact, for example, the separation for a system default language in German is semi-colon (";", while for English it is comma (","). Therefore, in the German case, the system preferences need to be updated by the user.

In the CSV file, the format should be of the type as shown for example in Figure 3. The first row consists of the header, which contains in the first column the alternatives type (e.g., countries) and from the second column on, the indicators names (e.g., Electricity as a business constraint, Control of corruption, SAIDI, etc.). From the second row, the actual dataset to be used in the tool needs to be included, where the first column needs to contain the names of the alternative and from the second column on the values of each indicator for the respective alternative. Except for both first row and first column, the rest of the table should be always populated by numbers, as shown in Figure 3.

	A	В	С	D	E	F
1	Scenarios	CO2 emissions world (t CO2 / d	CO2 emissions EU27 (t CO2 / c	Energy expenditure world (USD	Energy expenditure EU 27 (USE	Cumulated number of fatalities
2	BL	5.174693274	9.046484783	0.053781246	0.081594782	2130.104101
3	MT	3.819941762	6.54659621	0.055317007	0.080795715	1617.757387
4	EA	3.536957595	3.307686975	0.056573004	0.097447705	1526.410435
5	FT 1	1.282256789	1.639241254	0.079570971	0.112966867	965.0672657
6	FT 2	1.280740815	2.517729358	0.093384375	0.125402561	926.7994152
7	BL Nuc	5.423476958	9.299701768	0.054682127	0.082691835	2217.621395
8	MT Nuc	4.121992632	6.976895222	0.057415084	0.083879005	1745.846909
9	FT Nuc	1.366859942	3.1118879	0.093384375	0.125402561	1123.362397
10	BL Sh	4.243045567	5.807437935	0.05681289	0.083266607	1806.073246
11	MT Sh	3.279237929	4.626891423	0.058578046	0.082236961	1433.853936
12	EA Sh	3.209852705	3.007257856	0.058493984	0.098722004	1444.153936
13	MT CCS	3.923768666	6.895979719	0.055375334	0.080948148	1596.65294
14	EA CCS	3.672655643	3.7167295	0.056681753	0.098100839	1498.371454
15	FT CCS	1.432841471	2.954240001	0.09578754	0.128844029	635.4888652

FIGURE 3: SAMPLE OF AN INPUT DATASET FOR THE MCDA INDEX TOOL

#### 2.4 Data import

In the "Input data" page, to import the dataset for analysis, the user needs to click "Browse", select the CSV data file and upload the file. After this operation the dataset should be shown in the same page, under the heading "Data" (see Figure 4).

Account of the intervence o							
Instruction       Substruction       Substruction         Section       Substruction       Substruction </th <th>MCDA Index Tool</th> <th>Input dat</th> <th></th> <th></th> <th></th> <th></th> <th></th>	MCDA Index Tool	Input dat					
input data       input data       input data       input data         input data       Disput data       Dis		Welcome to M	CDA Index Tool!				
Seture       Defaultion       Defaultion         Particle       Particle       Particle         Normalization       Particle       Particle         Particle       Particle       Particle         Normalization       Particle       Particle       Particle         Particle       Particle       Particle       Particle       Particle         Particle       Particle       Particle       Particle       Particle       Particle         Particle <t< th=""><th>🕒 input data</th><th>1) Only the nun</th><th>nbers (including decimals) shown (i.e. visible) in the Excel fi</th><th>ie will actually be saved in the CSV.</th><th>re saving as a CSV file. Please NOTE that:</th><th></th><th></th></t<>	🕒 input data	1) Only the nun	nbers (including decimals) shown (i.e. visible) in the Excel fi	ie will actually be saved in the CSV.	re saving as a CSV file. Please NOTE that:		
Head         Exclassion of local scale         Second s		Data format: Fi	rst column for the alternatives and the remaining columns	for the performance of the alternatives on the oriteria. The	performances of the alternatives should be numerical value	s. Download a sample file.	
Autor         Second State           Name         Second State         Second St	Settings and weighting	Filename:	MCDA index tool manual csv	Brows	<b>6</b>		
Area           Image: Area           Area         Area           Area <th>-</th> <td>Note to file:</td> <td></td> <td></td> <td></td> <td></td> <td></td>	-	Note to file:					
Results: Indice and raiking         Commission of Biology (Section of Section of Sectin of Section of Sectin of Section of Section of Sectin of	E Construction of the indices	THUR UP IT.					
Results: Indice and raising         Security         Comparison of the security         Result security		Upload					
Result: indice and ranking         Info         Info <th< td=""><th>Normalization</th><td>Data</td><td></td><td></td><td></td><td></td><td></td></th<>	Normalization	Data					
No.         199         0.053         0.066         0.605         0.605         0.605           Results: Rack frequency matrix         10         1.57         0.606         0.074         0.640         0.555           Results: Rack frequency matrix         17         1.282         0.676         0.617         0.617         0.657           Results: Score bar Charts         17         1.282         0.677         0.627         0.554           Results: Score bar Charts         17         0.657         0.627         0.544           Results: Score bar Charts         17         0.657         0.627         0.544           Results: Score bar Charts         17         0.657         0.627         0.544           Results: Rackings comparing         16         0.657         0.627         0.544           Results: Rackings comparing         16         0.654         0.627         0.542           Results: Rackings comparing         16		Scenarios	CO2 emissions world (t CO2 / cap)	Energy expenditure world (USD / GDP)	Energy expenditure EU 27 (USD / GDP)	Diversity world oil market (Factor)	Diversity world gas market (Factor)
Results: Start Request, Marcine Start	OB Results: Indices and rankings	BL.	5.1747	0.0538	0.0816	0.658	0.5613
Results: Stark the liquid split is a split split split is a split is a split is a split is a split		MT	3.8199	0.0553	0.0808	0.6406	0.5488
n1         123         0290         0395         0313         0.674         0.584           Results Scores bar Charts         12         1260         0.695         0.617         0.627         0.626         0.647           Results Scores bar Charts         126         6.255         0.674         0.627         0.627         0.546           Results Scores bar Charts         126         0.527         0.637         0.627         0.546           Results Scores bar Charts         126         0.527         0.674         0.627         0.546           Mass         12.02         0.674         0.637         0.627         0.546           Mass         12.02         0.674         0.637         0.627         0.556           Mass         12.02         0.694         0.637         0.751         0.751           Abot         1270         0.694         0.697         0.726         0.647           Background State         12.02         0.697         0.697         0.647         0.697           Background State         12.02         0.697         0.691         0.697         0.697         0.697           Background State         12.02         12.02         0.697 <th< td=""><th>I Results: Rank frequency matrix</th><td>EA</td><td>3.537</td><td>0.0566</td><td>0.0974</td><td>0.644</td><td>0.5205</td></th<>	I Results: Rank frequency matrix	EA	3.537	0.0566	0.0974	0.644	0.5205
Baskingsterment         Bilon         Statist         Option         Option <t< td=""><th></th><td>FT 1</td><td>1.2823</td><td>0.0796</td><td>0.113</td><td>0.6374</td><td>0.5586</td></t<>		FT 1	1.2823	0.0796	0.113	0.6374	0.5586
No.         5425         01547         01877         01		FT 2	1.2807	0.0934	0.1254	0.6729	0.506
*Reading comparison         F1 No.         1 560         0.034         0.126         0.602         0.591           Bob         424         0.664         0.633         0.714         0.755           Abot         M19         3.792         0.664         0.682         0.756         0.726           Abot         M19         3.090         0.6964         0.692         0.759         0.726           Background material         M10         3.290         0.6964         0.609         0.614         0.596           Background material         6.027         0.697         0.6041         0.507         0.597	HII Results: Scores bar charts	BL Nuc	5.4235	0.0547	0.0827	0.6627	0.5446
Abot         0.654         0.613         0.714         0.7751           Abot         M7.9         2.792         0.6964         0.6022         0.7254         0.7265           Abot         M7.9         3.793         0.6954         0.6022         0.7254         0.7265           Background material         M7.05         3.704         0.5054         0.6097         0.7274         0.8046           Background material         M7.05         3.727         0.6567         0.6091         0.6147         0.5079		MT Nuc	4.122	0.0574	0.0839	0.6425	0.5362
Abot         M 50         3 292         0.5584         0.6822         0.7554         0.726           64.9         3 209         0.659         0.097         0.772         0.864           Background material         M 7C3         3 203         0.0564         0.0091         0.617         0.5379	Results: Rankings comparisons	FT Nuc	1.3669	0.0934	0.1254	0.6522	0.5391
Anote         Image: Constraint of the second of the s		BL Sh	4.243	0.0568	0.0833	0.7314	0.7751
Background material         MT CCS         3/238         0.0054         0.0009         0.6114         0.5056           EA CCS         3/6727         0.0567         0.0981         0.6477         0.5179	i About	MT Sh	3.2792	0.0586	0.0822	0.7258	0.7826
Background material         Earch         Earch <th></th> <td>EA Sh</td> <td>3.2099</td> <td>0.0585</td> <td>0.0987</td> <td>0.7272</td> <td>0.8048</td>		EA Sh	3.2099	0.0585	0.0987	0.7272	0.8048
EA CCS 3.6227 0.0567 0.0981 0.6467 0.5379		MTCCS	3.9238	0.0554	0.0809	0.6414	0.5496
FT CCS 1.4228 0.0958 0.1288 0.6698 0.548	ackground material	EA CCS	3.6727	0.0567	0.0981	0.6447	0.5379
		FT CCS	1.4328	0.0958	0.1288	0.6698	0.548

FIGURE 4: IMPORTED DATASET FOR ANALYSIS

#### 2.5 Selection of indicators' settings and weighting

In the "Settings and weighting" page (Figure 5), for each indicator its polarity, unit, and weight can be assigned in the setting panel.

MCDA Index Tool	Settings and weighting						
input data	In this section, you can: 1) Define the polarity of the criteria by clicking on the re- 2) Indicate the measurement unit (optional); and 3) Weight the criteria <sup>A</sup> . * positive polarity (arrow upwards) = the higher the value of		vation: negative				
-	polarity (arrow downwards) = the lower the value of the crit ^ weights in weighted sums (used in this tool) are trade off	terion the better for the evoluation.					
	indicator x that can be compensated by indicator y. For det	tails click here					
Settings and weighting	If you want to input the criteria weights by respecting th	is requirement, please click here (	SWING method):				
Construction of the indices	Item	Polarity	Range	Unit	Sider	Weights	Normalized Weights
Construction of the indices	1 CO2 emissions world (t CO2 / cap)	4	1.28 - 5.42			0.68	0.37
	2 Energy expenditure world (USD / GDP)	4	0.05 - 0.10			0.42	0.23
Normalization	3 Energy expenditure EU 27 (USD / GDP)	4	0.08 - 0.13			0.57	0.31
	4 Diversity world oil market (Factor)	+ +	0.64 - 0.73			0.11	0.06
Results: Indices and rankings	5 Diversity world gas market (Factor)	+	0.51 - 0.80			0.04	0.02
III Results: Rank frequency matrix							
Results: Rankings comparisons							
Background material							

FIGURE 5: SETTINGS AND WEIGHTING PAGE

The user can define the polarity of each indicator by clicking on the respective arrow. A positive polarity (arrow upwards, green color) means the higher the value of the criterion the better for the evaluation, while a negative polarity (arrow downwards, red color) indicates that the lower the value of the criterion the better for the evaluation.

Next, the user can indicate the measurement unit for each indicator. This is not a mandatory field, but its use is recommended. Furthermore, the user can slide the bar to assign indicator weights. The scale of the weights for each indicator is not fixed, but it is automatically normalized by the tool to sum up to 1.0 (see last column of Figure 5). In the Weighted Sum Approach (WSA), the weights are trade-off coefficients, meaning that they indicate, for example, that a decrease in indicator x can be compensated by an increase in indicator y. The user could also use the so-called SWING method to assign weights (Riabacke et al. 2012). The SWING method consists of a set of three tasks (Figure 6):

- *Task 1*: rank the indicators from the most (at the top) to the least important (at the bottom);
- *Task 2*: select importance level by assigning the highest number of points (e.g., 100) to the most important criterion;
- Task 3: assign points to each subsequent criterion to reflect the increase in the overall value for the change from the worst to the best performance on the selected criterion in comparison (%) to the increase from the worst to the best performance of the most important criterion.

Finally, once the weights have been assigned, either manually or using the SWING method, the normalized weights will be automatically calculated in order to keep the sum of the weights equal to 1.

MCDA Index Tool											
	1) Def	s section, you can: fine the polarity of the criteria by clicking on I	he respective arrow*;				least important (at the bottom);				
📄 Input data	3) We *: pos polari	licate the measurement unit (optional); and light the criteria <sup>1</sup> , itive polarity (arrow upwards) = the higher the i ty (arrow downwords) = the lower the value of I give in weighted sums (used in this too) are tra	he criterion the better for the evaluation.		<ol> <li>Assign points to each to reflect the increase in selected criterion in com</li> </ol>	subsequent criterion, by set the overall value for the ch	place on the bar, to the most imports lecting the relevant place on the bar, ange from the worst to the best performant from the worst to the best performant	rmance on the			
🖒 Settings and weighting	Indica	tor x that can be compensated by indicator y. I want to input the criteria weights by respect	or details click here.		4: Based on the chosen i	weights in the respective co	slumn, the normalized weights will be	automatically			
Construction of the indices		item	Polarity	Range		Unit	Slider		Weights	Normalized Weights	
E Construction of the indices	1	CO2 emissions world (t CO2 / cap)	4	1.28 - 5.42					0.87	0.38	
	2	Energy expenditure world (USD / GDP)	4	0.05 - 0.10					0.67	0.29	
Normalization		Energy expenditure EU 27 (USD / GDP)	4	0.08 - 0.13					0.44	0.19	
		Diversity world oil market (Factor)		0.64 - 0.73					0.28	0.12	- 1
O Results: Indices and rankings	5	Diversity world gas market (Factor)	t	0.51 - 0.80					0.04	0.02	
III Results: Rank frequency matrix											
Lill Results: Scores bar charts											
2 Results: Rankings comparisons											
1 About											
Background material											

FIGURE 6: EXAMPLE OF THE APPLICATION OF THE SWING METHOD TO THE SAMPLE DATA

#### 2.6 Selection of normalization methods and aggregation functions

In the page "Construction of the indices", the user can select the normalization methods and aggregation functions to be used to build the indices (Figure 7). Normalization methods transform all the indicators on the same scale and make them comparable. There are 8 normalization methods implemented in the tool:

- 1. Rank;
- 2. Percentile Rank;
- 3. Standardized;
- 4. Minmax;
- 5. Target;
- 6. Logistic;
- 7. Categorical (-1; 0; 1);
- 8. Categorical (0.1; 0.2; 0.4; 0.6; 0.8; 1).

Aggregation functions integrate all the indicators on the same scale into an index. Five aggregation methods available: Additive, Geometric, Harmonic, Minimum, and Median. The user can select the

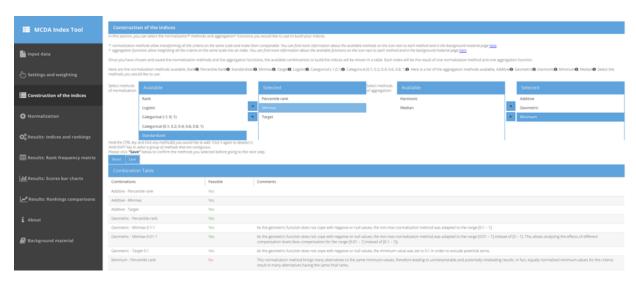


FIGURE 7: SELECTION WINDOW OF THE NORMALIZATION METHODS AND AGGREGATION FUNCTIONS

aggregation functions in the same way as the normalization. For each of the options, the user can find more information on the icon next to the method name or in the "Background material" page.

Once all the methods under interest have been selected, the user should click on the "Save" button to confirm the choices before continuing to next step. At this point, the tool will request through a pop-up window (Figure 8) whether the user is interested to save (by clicking "OK") or not (by clicking "Cancel") the original data, the configuration settings and the selected methods in a CSV file (Figure 9).

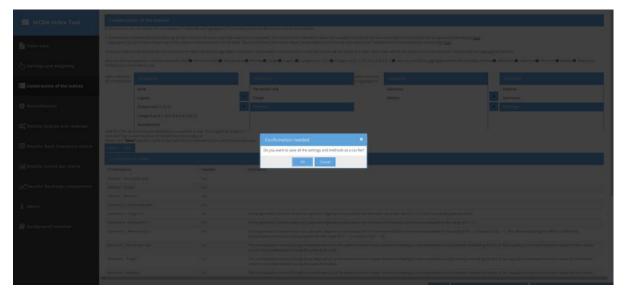


FIGURE 8: CONFIRMATION OF THE NORMALIZATION AND AGGREGATION METHODS FOR THE DATA UNDER INTEREST

This file is used as "restore" point, meaning that the user could upload it at the "Input data" page in order to restore the current analysis. However, it is recommended that this file is not edited by the user because any erroneous modification may result in a non-successful restore process. After the user has confirmed his decision, all the available normalization-aggregation combinations to build the indices are shown in the combination table on the "Construction of the indices page" (Figure 9). Each index is the result of one normalization method and one aggregation function.

A	В	c	D	E	F
Please do NOT edit or update anythin	g if you want to upload this file to r	estore the settings.			
Polarity (True:'Upwards'/False:'Down	wards')				
Normalizations (1:'Rank'/ 2:'Percentil	e rank'/ 3:'Standardized'/ 4:'Minma	x'/ 5:'Target'/ 6:'Logistic'/ 7:'Categ	orical (-1;0;1)'/ 8:'Categorical (0.1;	0.2;0.4;0.6;0.8;1)')	
Aggregations (1:'Additive'/ 2:'Geome	tric'/ 3:'Harmonic'/ 4:'Minimum'/ 5	:'Median')			
*configuration = 2 (1 = default weight	Polarity	Range	Unit	Weights	Normalized Weights
CO2 emissions world (t CO2 / cap)	FALSE	1.28 - 5.42		0.87	0.3782608
Energy expenditure world (USD / GDP	FALSE	0.05 - 0.10		0.67	0.29130434
Energy expenditure EU 27 (USD / GDF	FALSE	0.08 - 0.13		0.44	0.19130434
Diversity world oil market (Factor)	TRUE	0.64 - 0.73		0.28	0.1217391
Diversity world gas market (Factor)	TRUE	0.51 - 0.80		0.04	0.01739130
*normalizations	2	5	4	l	
*aggregations	1	2	4	1	
*data=0(0 default)					
5 Scenarios	CO2 emissions world (t CO2 / cap)	Energy expenditure world (USD / C	Energy expenditure EU 27 (USD /	Diversity world oil market (Factor)	Diversity world gas market (Facto
5 BL	5.174693274	0.053781246	0.081594782	0.658008224	0.56129719
7 MT	3.819941762	0.055317007	0.080795715	0.640580759	0.54881926
B EA	3.536957595	0.056573004	0.097447705	0.643998586	0.52045157
9 FT 1	1.282256789	0.079570971	0.112966867	0.637424274	0.55855357
5 FT 2	1.280740815	0.093384375	0.125402561	0.672934495	0.50595136
1 BL Nuc	5.423476958	0.054682127	0.082691835	0.662650524	0.54461829
2 MT Nuc	4.121992632	0.057415084	0.083879005	0.642529767	0.53622094
FT Nuc	1.366859942	0.093384375	0.125402561	0.652192724	0.53905656
1 BL Sh	4.243045567	0.05681289	0.083266607	0.731363262	0.7750619
5 MT Sh	3.279237929	0.058578046	0.082236961	0.725820939	0.78264540
EA Sh	3.209852705	0.058493984	0.098722004	0.727165452	0.80478503
7 MT CCS	3.923768666	0.055375334	0.080948148	0.641356595	0.54963063
EA CCS	3.672655643	0.056681753	0.098100839	0.644697037	0.53793045
FT CCS	1.432841471	0.09578754	0.128844029	0.66977586	0.54800015

FIGURE 9: FORMAT OF THE CONFIGURATION CSV FILE

#### 2.7 Normalization output

These tabs show the normalized dataset according to the normalization methods that the user selected (Figure 10). It is possible to directly compare the alternatives with respect to one or several indicators. The user can also save the results by clicking on the button "Save as CSV" at the bottom of the page.

MCDA Index Tool	Normalize	d dataset				
	These wind					
input data	Percentile ran	-				
Settings and weighting	Scenarios	CO2 emissions world (t CO2 / cap)	Energy expenditure world (USD / GDP)	Energy expenditure EU 27 (USD / GDP)	Diversity world oil market (Factor)	Diversity world gas market (Factor)
-) seconds and weighting	BL.	0.1333	0.9333	0.8	0.5333	0.7333
	MT	0.4	0.8	0.9333	0.1333	0.5333
Construction of the indices	EA	0.5333	0.6667	0.4667	0.3333	0.1333
	FT 1	0.8667	0.2667	0.2667	0.0667	0.6667
Normalization	FT 2	0.9333	0.2	0.2	0.7333	0.0667
	BL Nuc	0.0667	0.8667	0.6667	0.6	0.4
Results: Indices and rankings	MT Nuc	0.2667	0.4667	0.5333	0.2667	0.2
-	FT Nuc	0.8	0.2	0.2	0.4667	0.3333
Results: Rank frequency matrix	BL Sh	0.2	0.5333	0.6	0.9333	0.8
B results, Rank frequency matrix	MT Sh	0.6	0.3333	0.7333	0.8	0.8667
	EA.Sh	0.6667	0.4	0.3333	0.8667	0.9333
I Results: Scores bar charts	MTCCS	0.3333	0.7333	0.8667	0.2	0.6
	EA.CCS	0.4667	0.6	0.4	0.4	0.2667
Results: Rankings comparisons	FT CCS	0.7333	0.0667	0.0667	0.6667	0.4667
	Save As CSV					
About						
Background material						
	-					
						Previous

FIGURE 10: RESULTS OF THE DATASET NORMALIZATION. EACH TABLE CORRESPONDS TO ONE OF THE SELECTED NORMALIZATION METHODS

#### 2.8 Results: Indices and rankings

These panels show the raw scores of the indices, their normalized scores and the rankings for each of the previously selected normalization-aggregation combinations (Figure 11). The user can directly compare the alternatives with the latter two tabs. The user can also save the results by clicking on the button "Save as CSV" at the bottom of the page.

MCDA Index Tool	Indices an							
🔓 Input data	You can dir							
	Scores Sc							
🖰 Settings and weighting	Scenarios	Additive - Percentile rank	Additive - Target	Additive - Minmax	Geometric - Percentile rank	Geometric - Target 0.1	Geometric - Minmax 0.1- 1	Geometric - Minmax 0.01-1
Construction of the indices	BL	0.553	0.3369	0.532	0.4038	0.3251	0.4143	0.2949
	MT	0.5884	0.4247	0.625	0.5061	0.4616	0.556	0.4589
Normalization	EA	0.5281	0.4159	0.5786	0.5115	0.4519	0.5494	0.4717
	FT 1	0.4762	0.4799	0.5569	0.3575	0.4449	0.4893	0.3427
C Results: Indices and rankings	FT 2	0.54	0.4243	0.4546	0.4116	0.3272	0.3552	0.2307
See Results: Indices and rankings	BL Nuc	0.4852	0.3156	0.5038	0.2947	0.2829	0.3531	0.1427
	MT Nuc	0.3748	0.3928	0.5723	0.3566	0.4271	0.5174	0.4309
III Results: Rank frequency matrix	FT Nuc	0.4617	0.4156	0.4218	0.3779	0.3241	0.3318	0.2157
	8L.Sh	0.4733	0.407	0.6969	0.4058	0.4273	0.6567	0.6072
III Results: Scores bar charts	MT Sh	0.5768	0.4696	0.77	0.5476	0.4992	0.771	0.7446
_	EA Sh	0.5542	0.451	0.7144	0.5225	0.475	0.7263	0.6964
Results: Rankings comparisons	MT CCS	0.5403	0.4172	0.6155	0.478	0.453	0.5486	0.4569
Results: Rankings comparisons	EA CCS	0.4812	0.4056	0.5647	0.4738	0.4412	0.5405	0.4673
	FT CCS	0.3988	0.4017	0.4087	0.2261	0.2925	0.2841	0.091
i About								
Background material	Save As CSV							

FIGURE 11: RESULTS OF THE AGGREGATION METHODS. THE FIRST TABLE INCLUDES THE RAW SCORES, THE SECOND SHOWS THE NORMALIZED SCORES AND THAT LAST TABLE PRESENTS THE RANKINGS ACCORDING TO EACH COMBINATION.

#### 2.9 Display frequency matrix (tooltip for each frequency value)

In this page, the rank frequency matrix is displayed. This plot shows the proportion (in %) of the combinations in each rank position (Figure 12). It is the number of the combinations that lead to that specific rank divided by the total number of the combinations. The user can move the cursor on the number in each box to learn which combination(s) rank the alternative under interest at that position, as example see the yellow box in Figure 12.

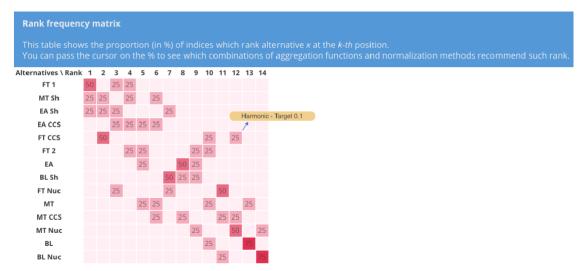


FIGURE 12: EXAMPLE OF RANK FREQUENCY RESULTS

# 2.10 Display bar graph (combo box to compare normalizations or aggregations)

This page shows the bar graph comparing the indices according to the selected normalization methods or aggregation functions (Figure 13).

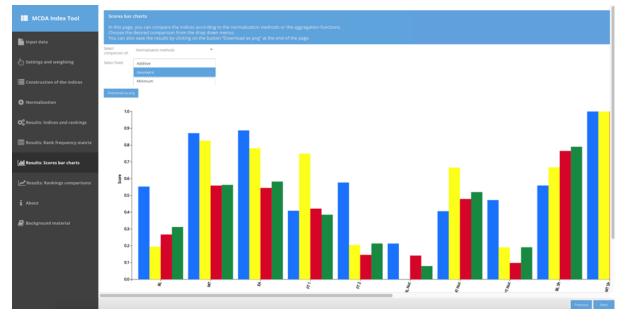


FIGURE 13: EXAMPLE OF BAR CHARTS FOR THE NORMALIZATION METHODS AND ADDITIVE AGGREGATION FUNCTION

In the drop down list, the user can select either "Normalization methods comparison" or "Aggregation methods comparison". If the user selects "Normalization methods comparison", then one aggregation

method should be selected from the second drop down list in the "Select fixed" option (Figure 13). On the contrary, if the user selects "Aggregation methods comparison", then one normalization method should be selected.

#### 2.11 Display line graph (checkbox to turn on/off each line)

In this section, the line graph is displayed according to the rankings of the feasible combinations (Figure 14). The alternatives are listed in an increasing order of expected rank based on all the ranks in all the combination ranks. The user can choose to show a specific line (i.e. combination) or not by selecting or deselecting the checkbox in the legend.



FIGURE 14: RANKING OF EACH ALTERNATIVE FOR ANY ALTERNATIVE FOR ONE OF THE FEASIBLE COMBINATIONS NORMALIZATION + AGGREGATION

#### 2.12 Supplementary pages (explanations for MCDA methods)

In the Background Materials page, five tabs with the background information are present (Figure 15). These tabs include the descriptions of the implemented methods and other practical information for the user:

- 1. Normalization methods;
- 2. Aggregation functions;
- 3. The feasible combinations among 1. and 2.;
- 4. The SWING weighting method;
- 5. The reference papers for the tool.

The user can check them in detail by clicking on each of them.

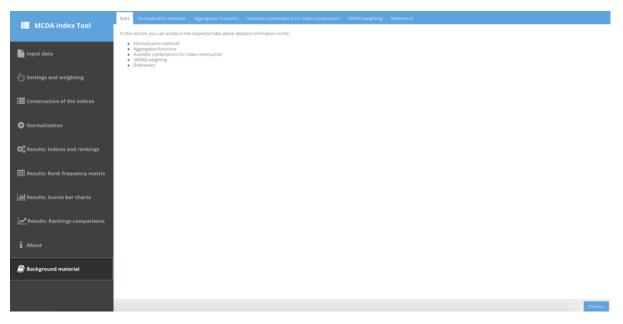


FIGURE 15: BACKGROUND MATERIALS PAGE INCLUDING SIX TABS

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