CERCOM

Circular Economy in Road COnstruction and Maintenance

Risk Based Analysis Framework

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Research Driven Solutions

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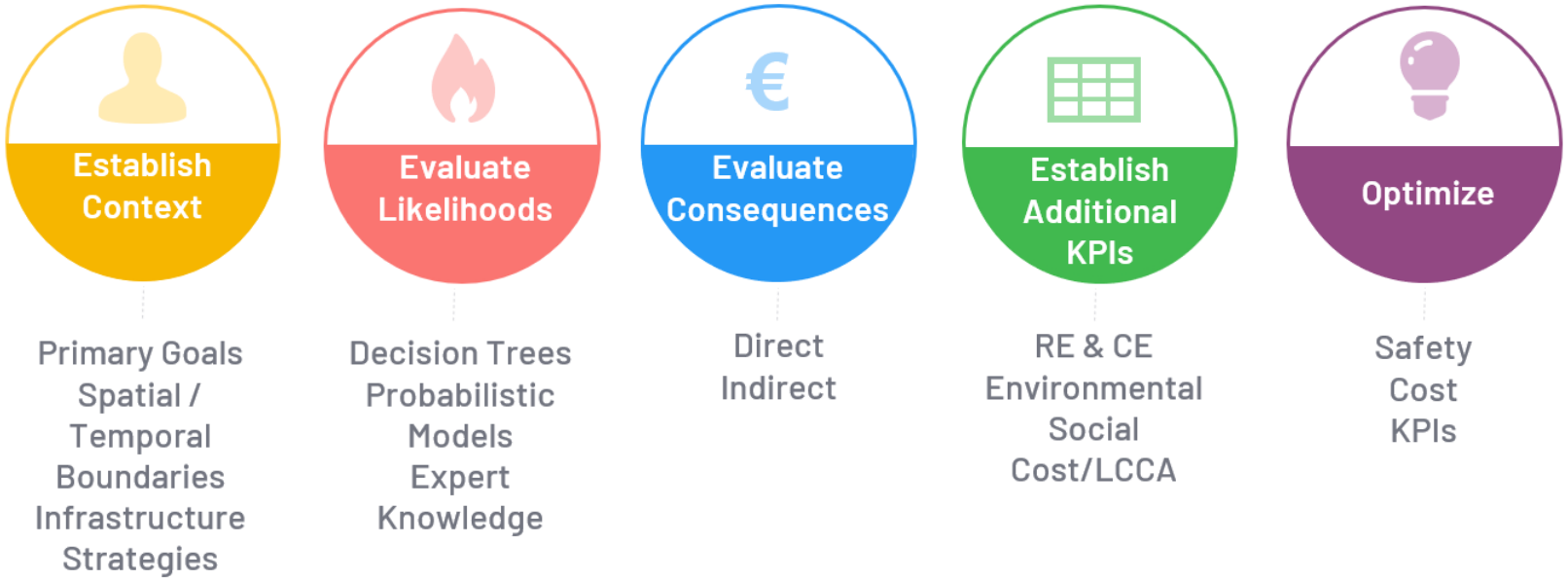
Collaborative Session 3 Outline

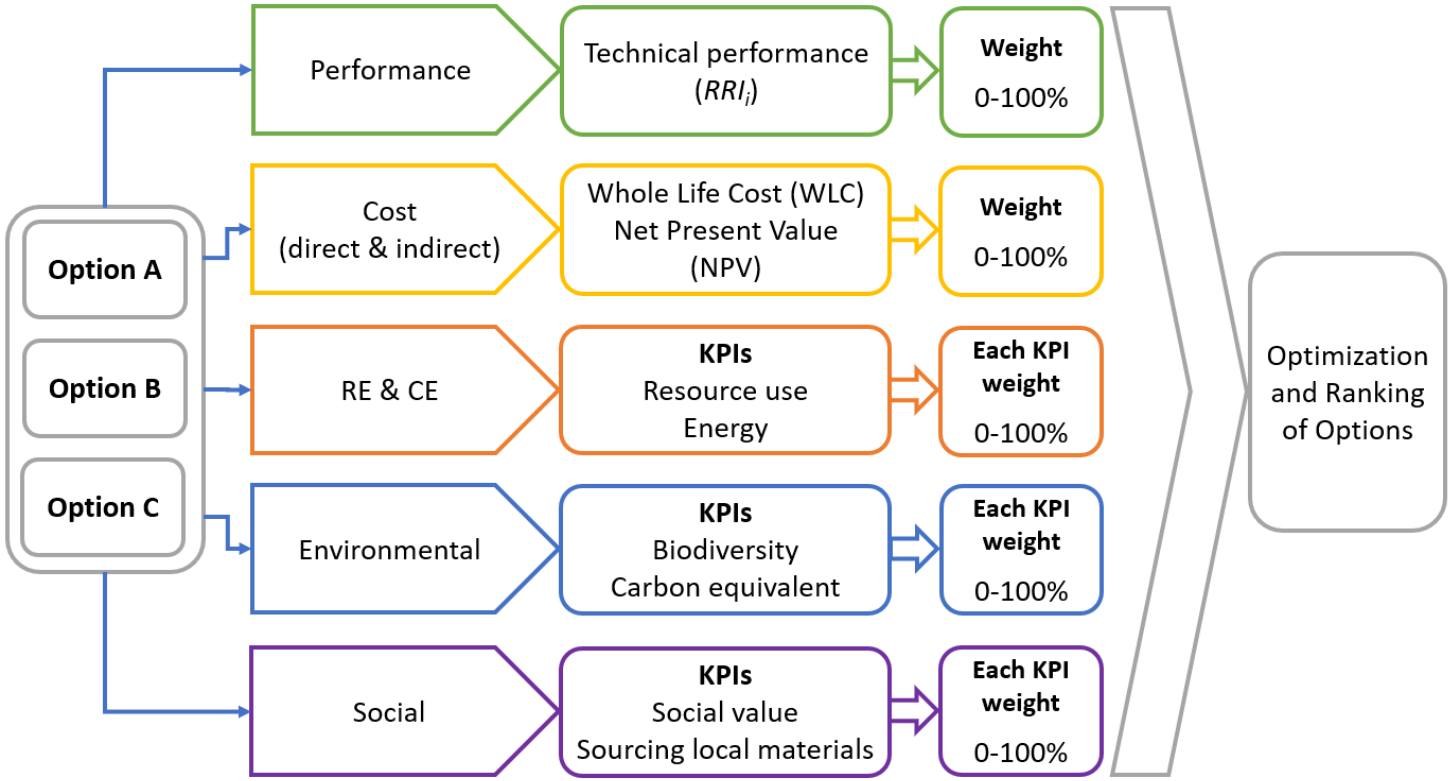
- RBAF and Software tool video demonstration 30 minutes
- CERCOM case study 15 minutes
- Discussion and feedback 30 minutes

Risk Based Analysis Framework (RBAF)

- Development of a framework to facilitate circular procurement with the ability to assess the technical risk of incorporating novel or innovative solutions into design, maintenance and construction of road infrastructure
- Assess current practice as well as more circular solutions



Development of Criteria/KPIs



Single Performance Metric

$$NRRG_i = w_1 \times RRI_i + w_2 \times CPI_i + w_3 \times KPI_{1,i} + w_4 \times KPI_{2,i} + \cdots$$

$KPI_{3,4,5\ldots,i}$ = Values of each KPI (between 0 and 1) associated with maintenance / construction option i;

$w_{1,2,3\ldots}$ = Values of weights for each KPI.

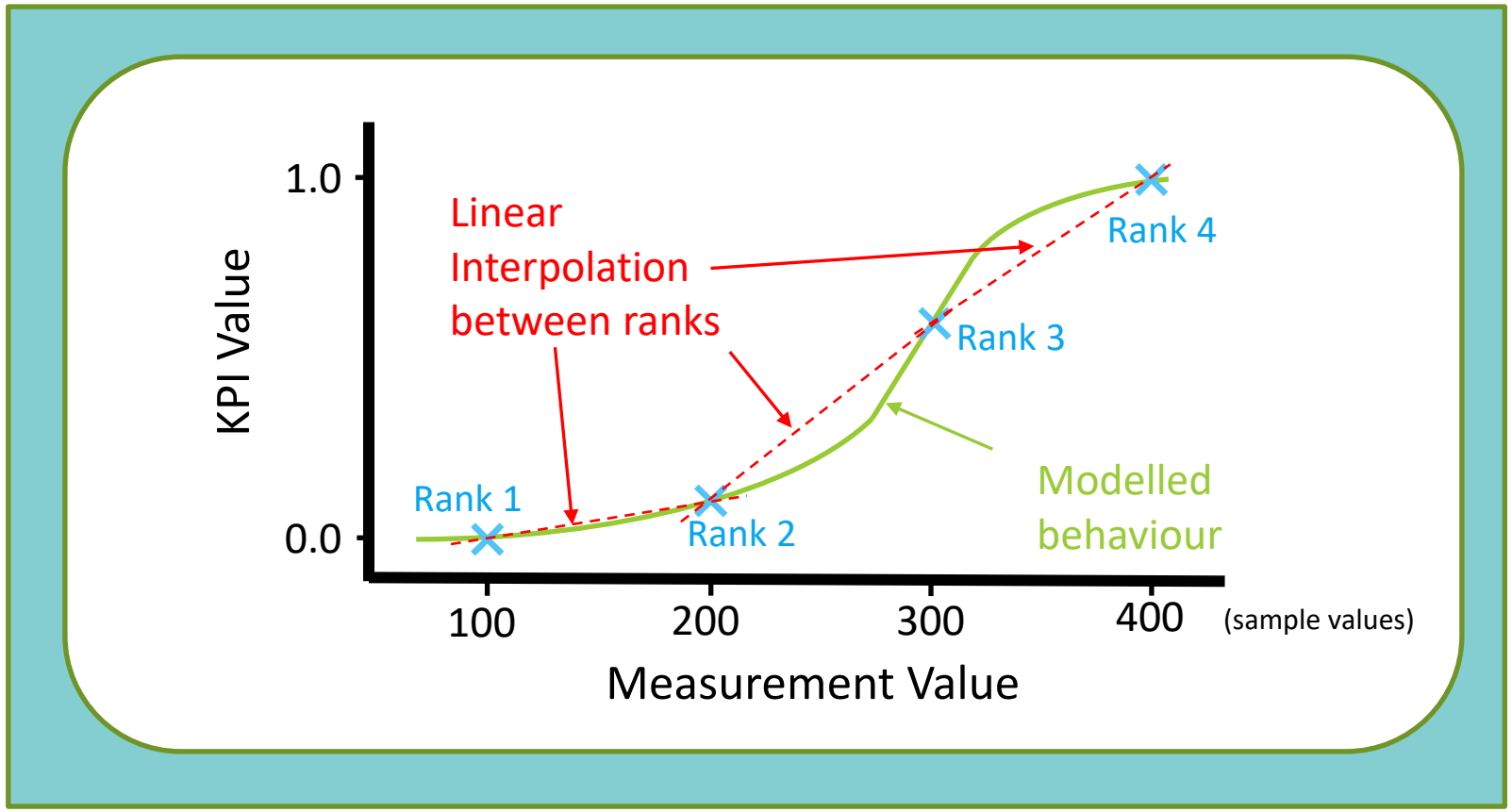
$$RRI_i = \frac{R - R_i}{R}$$

R = Risk associated with the "Do Nothing" option;
R_i = Risk associated with maintenance / construction option i;

$$CPI_i = \frac{B - C_i}{B}$$

B = Budget available for maintenance / construction activity;
C_i = Cost associated with maintenance / construction option i;

Additional KPIs: Ranked Interpolation



Rank 1 = minimum acceptable performance, KPI 0

Rank 2 = industry norm, established practice but not always applied, KPI 0.15

Rank 3 = industry leading performance, uncommon, KPI 0.6

Rank 4 = medium term goal, KPI 1.0.

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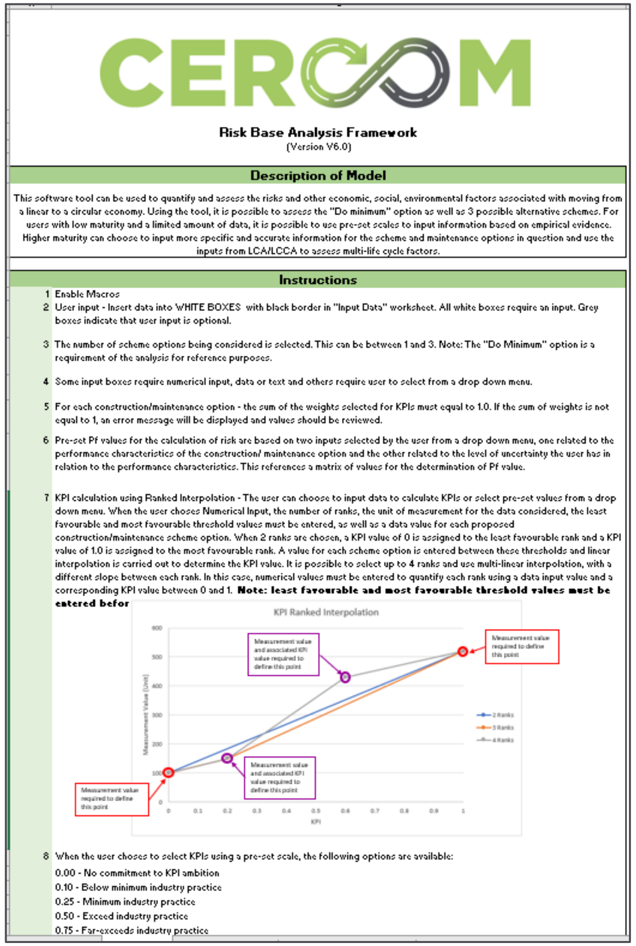
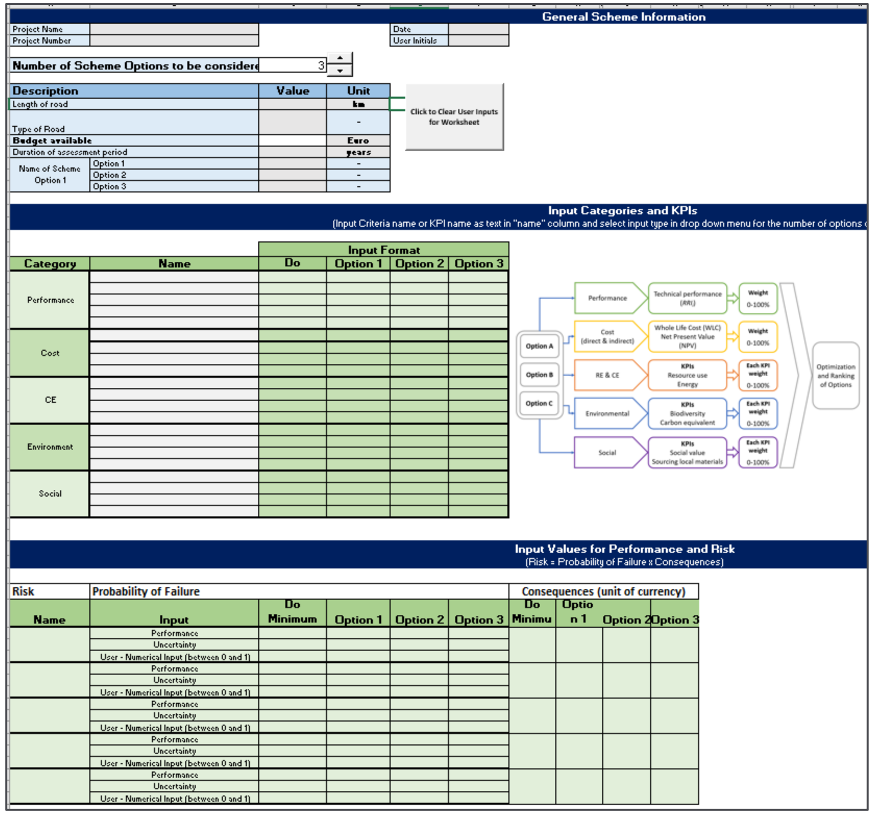
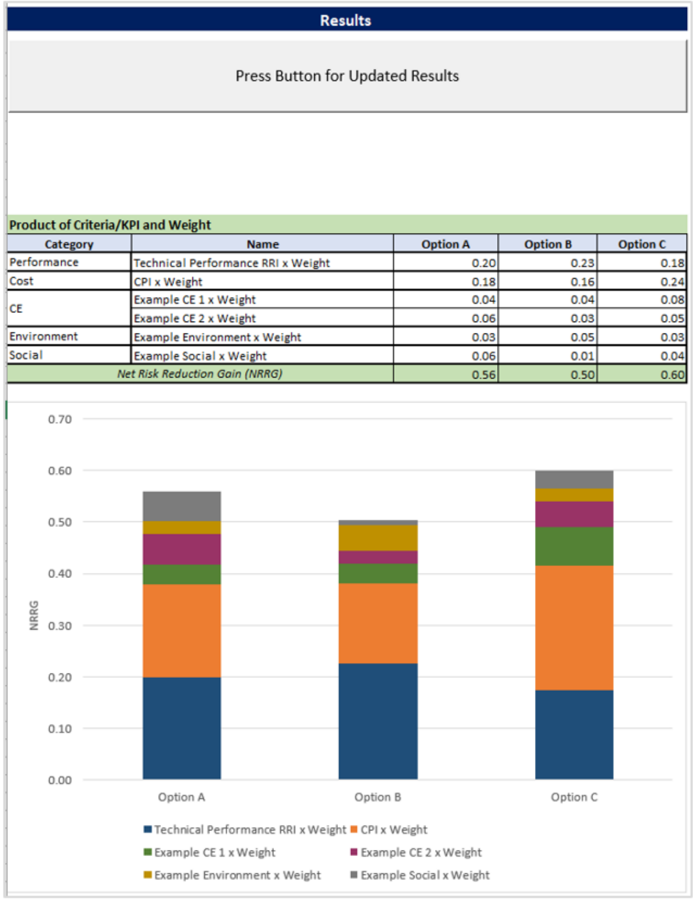
Risk Based Software Tool







Category	Name	Option A	Option B	Option C
Performance	Technical Performance RRI x Weight	0.20	0.23	0.18
Cost	CPI x Weight	0.18	0.16	0.24
CE	Example CE 1 x Weight	0.04	0.04	0.08
	Example CE 2 x Weight	0.06	0.03	0.05
Environment	Example Environment x Weight	0.03	0.05	0.03
Social	Example Social x Weight	0.06	0.01	0.04
	Net Risk Reduction Gain (NRRG)	0.56	0.50	0.60

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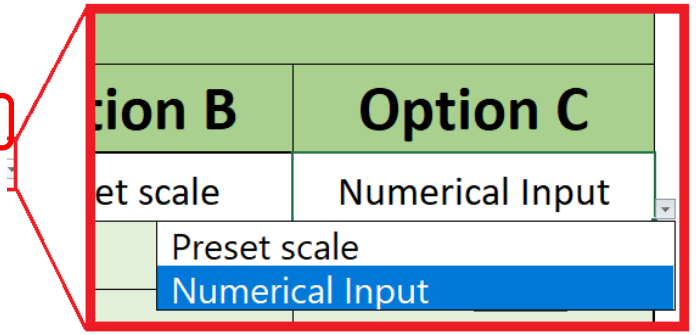
Input Format

Category	Name	Input Format			
		Do Minimum	Option A	Option B	Option C
Performance	Technical Performance	Preset scale	Numerical Input	Preset scale	Numerical Input
Cost	Cost (CPI)		Numerical Input	Numerical Input	Numerical Input
	Example Cost 2		Preset scale	Preset scale	Numerical Input
CE	Example CE 1		Numerical Input	Numerical Input	Preset scale
	Example CE 2		Numerical Input	Preset scale	Preset scale
Environment	Example Environment		Preset scale	Preset scale	Preset scale
Social	Example Social		Numerical Input	Preset scale	Numerical Input



For each white cell, user selects input format from drop down menu

Risk Assessment Input

Input Values for Performance and Risk
(Risk = Probability of Failure x Consequences)

Risk	Probability of Failure				
Name	**Input**	**Do Minimum**	**Option A**	**Option B**	**Option C**
Technical Performance	Performance	Above Average		Below Average	
	Uncertainty	Low		High	
	User - Numerical Input (between 0 and 1)				

Pre-set scale input

Numerical input

User provides estimate of performance and uncertainty for required options using drop down

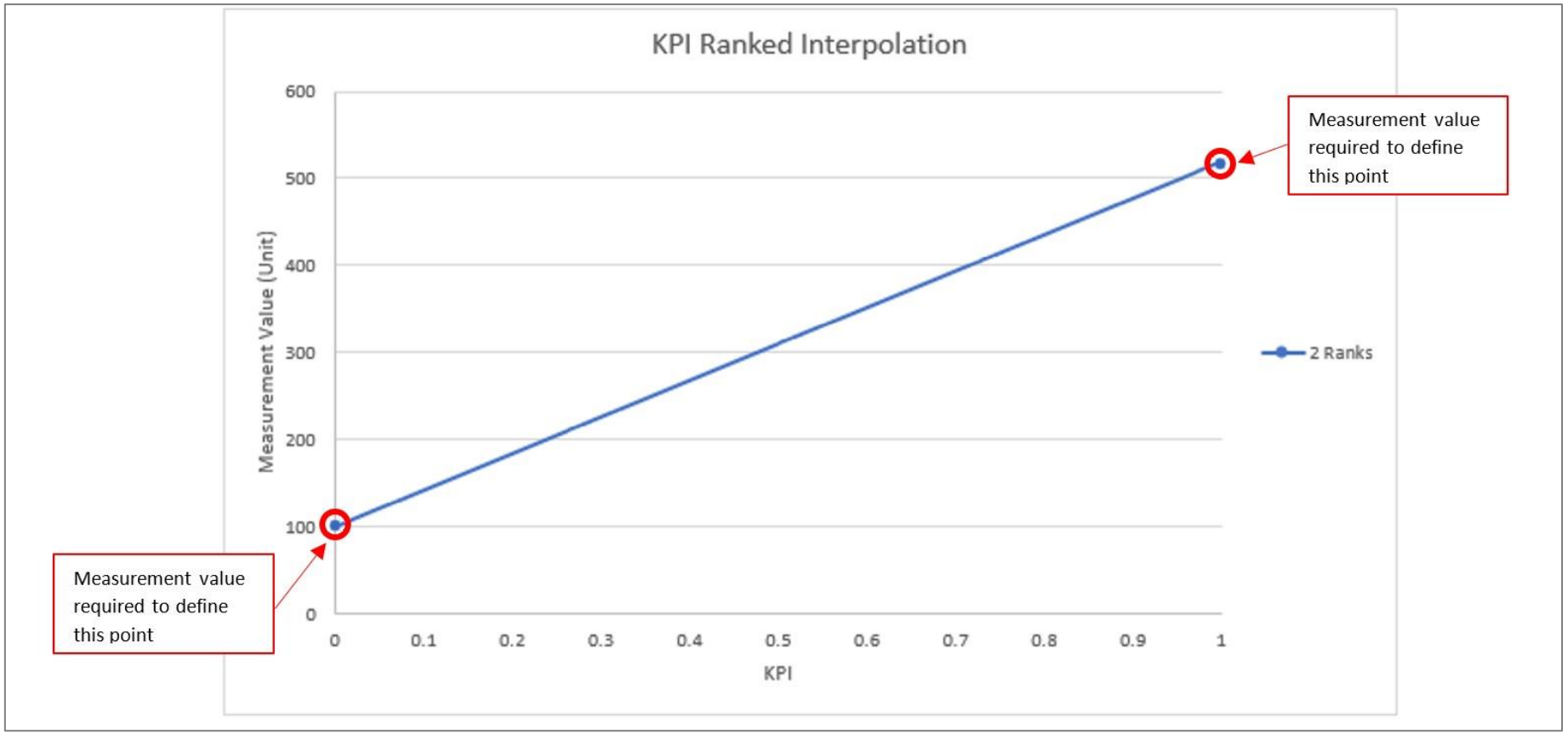
Risk	Probability of Failure				
Name	**Input**	**Do Minimum**	**Option A**	**Option B**	**Option C**
Technical Performance	Performance	Above Average		Below Average	
	Uncertainty	Low		High	
	User - Numerical Input (between 0 and 1)		0.2		0.15

Pre-set scale input

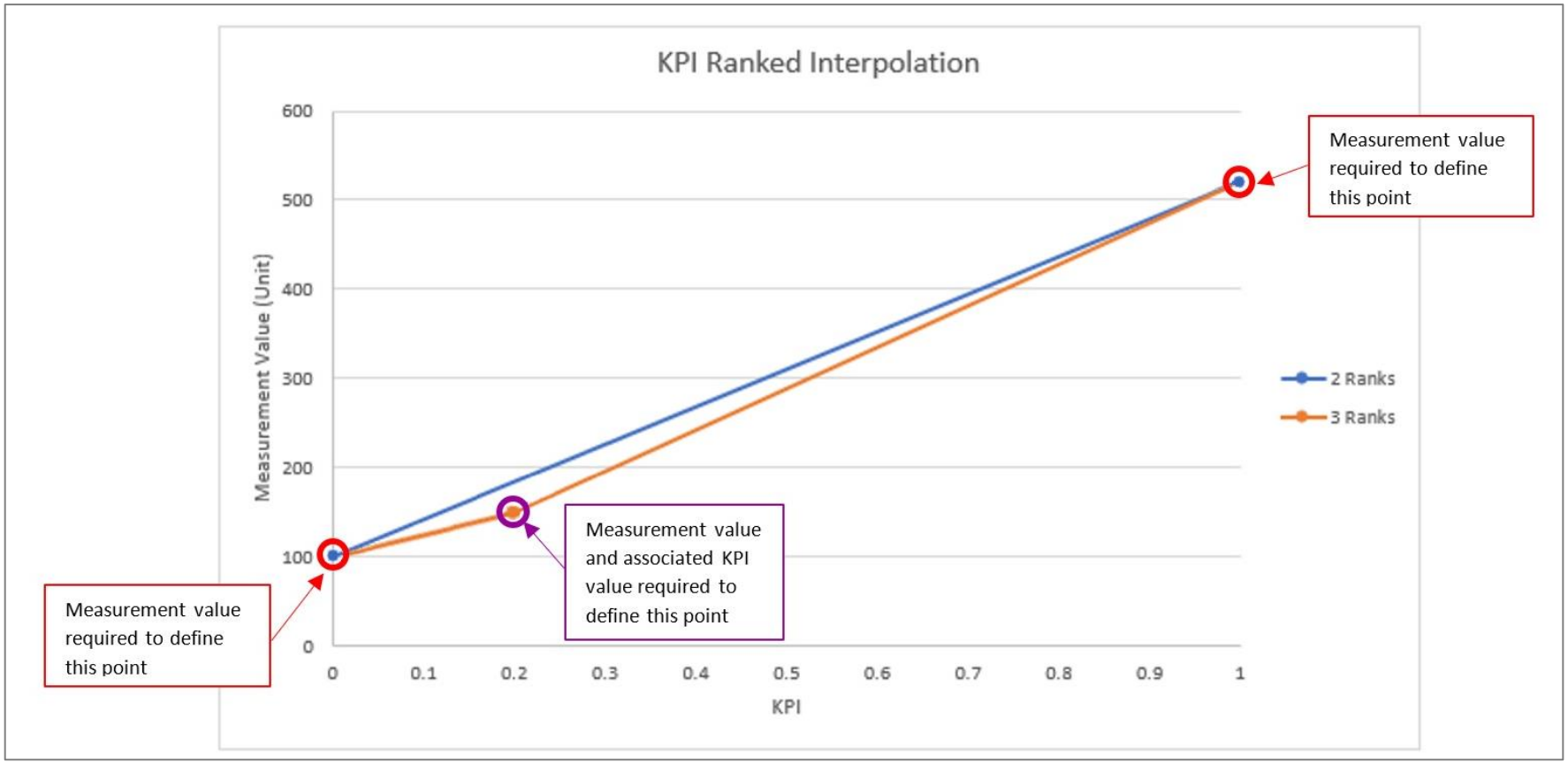
Numerical input

User numerical value for Pf (value between 0 and 1.0)

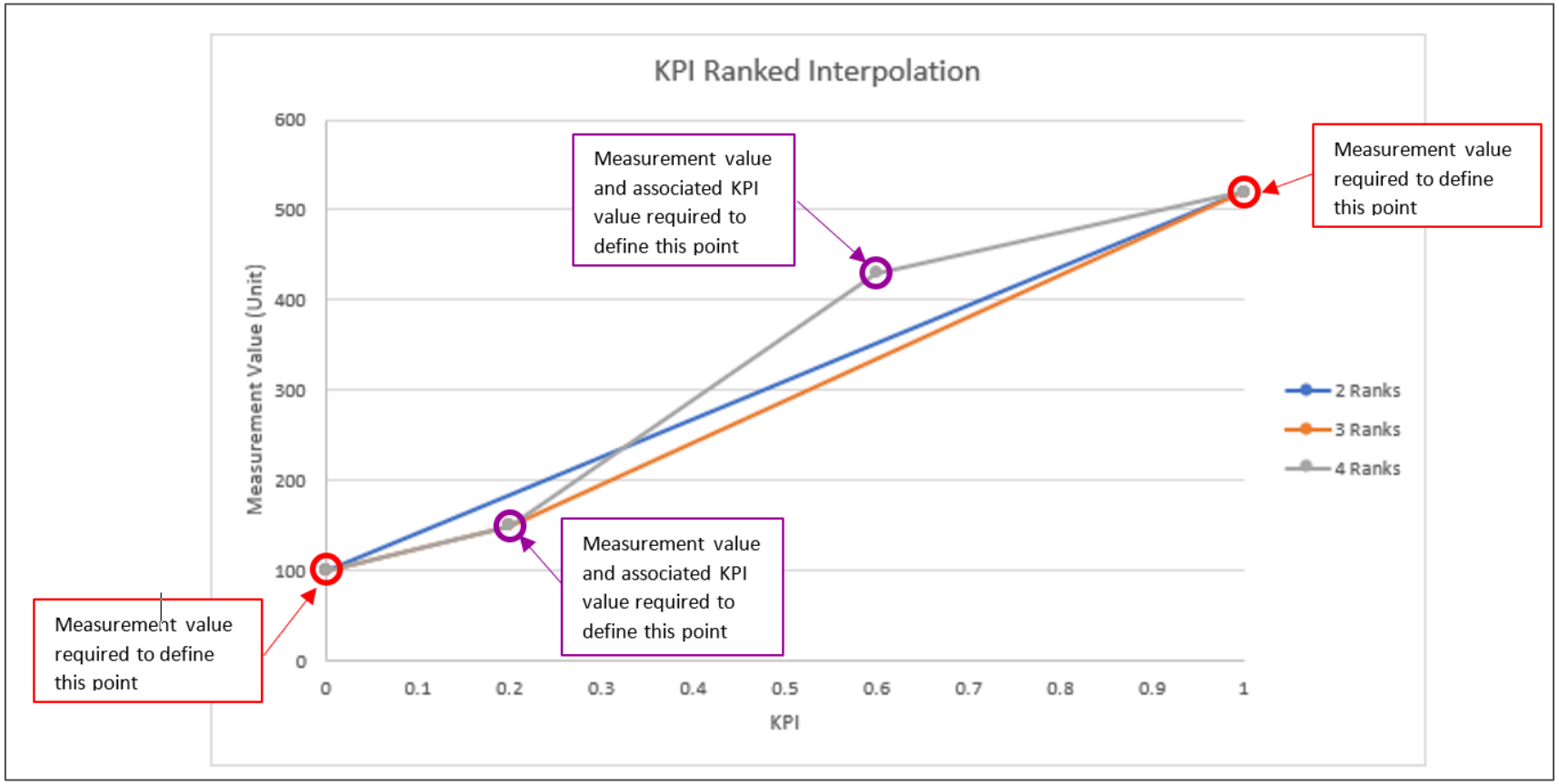
Ranked Interpolation



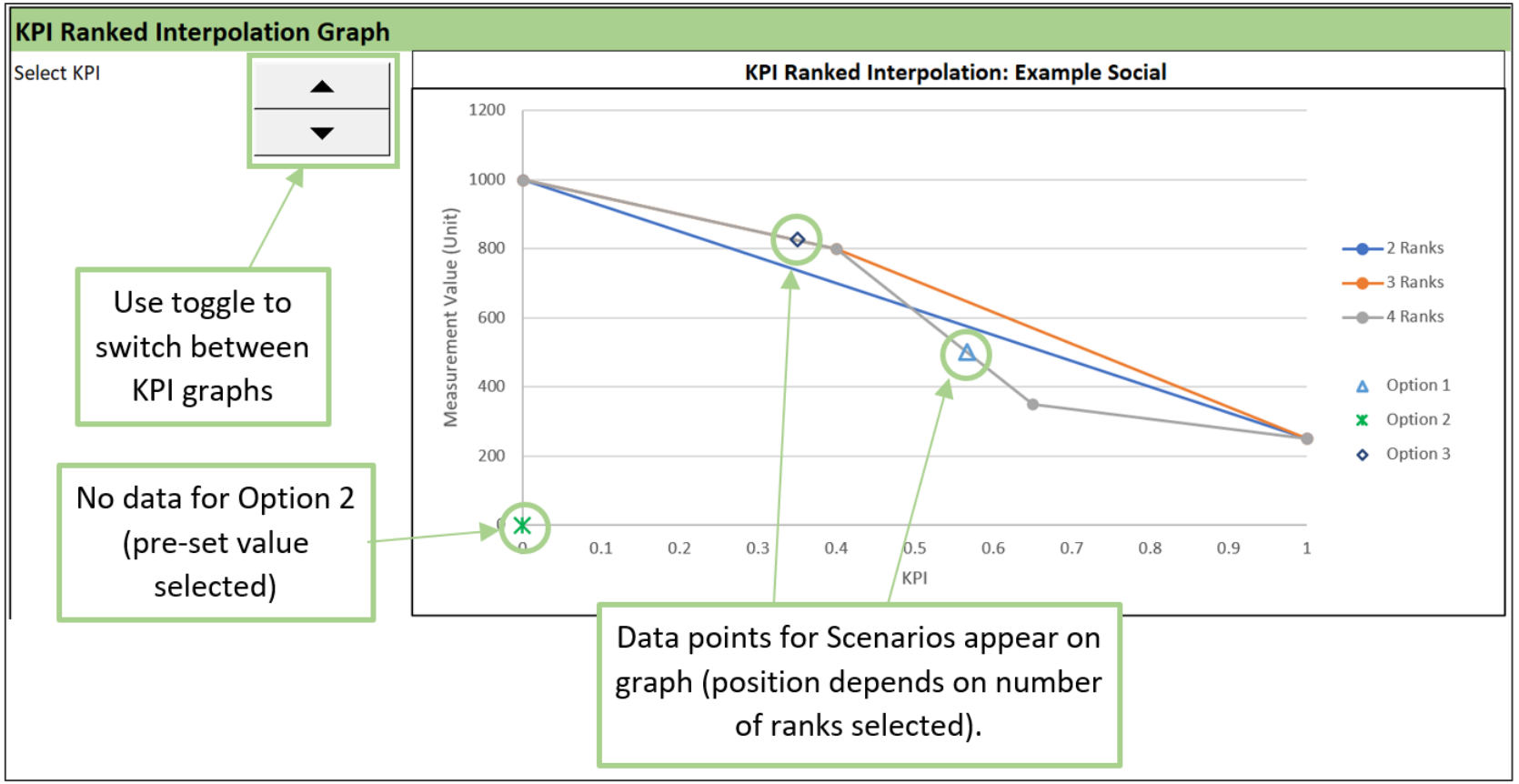
Ranked Interpolation



Ranked Interpolation



Ranked Interpolation



Additional KPIs: Pre-set Scale

KPI Value	Description
0	No commitment to KPI ambition
0.1	Below minimum industry practice
0.25	Minimum industry practice
0.5	Exceed industry practice
0.75	Far-exceeds industry practice
1	KPI ambition achieved

Weighting

Select Weights
(Input weight in white boxes between 0 and 1.0 - Note: Sum of weights for each option must equal 1.0)

Category	Name	Option A	Option B	Option C
Performance	Technical Performance	0.3	0.3	0.3
Cost	Cost (CPI)	0.2	0.2	0.2
	Example Cost 2	0.1	0.1	0.1
CE	Example CE 1	0.1	0.1	0.1
	Example CE 2	0.1	0.1	0.1
Environment	Example Environment	0.1	0.1	0.1
Social	Example Social	0.1	0.1	0.1

Input values for weights as indicated by white boxes

Sum of values in each column equals 1.0 ➡ No Error

Software tool results format

Results
Press Button for Updated Results

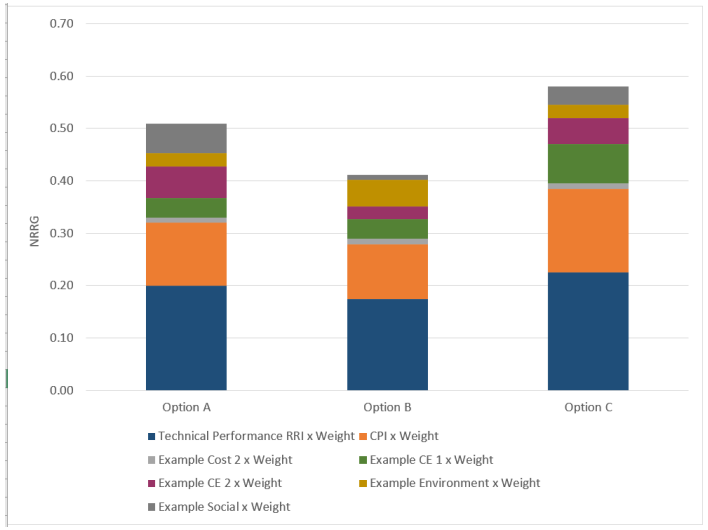
Click to obtain results

No error relating to weights

Product of Criteria/KPI and Weight

Category	Name	Option A	Option B	Option C
Performance	Technical Performance RRI x Weight	0.20	0.18	0.23
Cost	CPI x Weight	0.12	0.10	0.16
	Example Cost 2 x Weight	0.01	0.01	0.01
CE	Example CE 1 x Weight	0.04	0.04	0.08
	Example CE 2 x Weight	0.06	0.03	0.05
Environment	Example Environment x Weight	0.03	0.05	0.03
Social	Example Social x Weight	0.06	0.01	0.04
Net Risk Reduction Gain (NRRG)		0.51	0.41	0.58

NRRG results



Graph indicating contribution of each weighted criteria/KPI towards NRRG

Software Demonstration - Overview

Software Demonstration – Input data

Category	Indicator		Input	Do Nothing	No RA	20% RA	50% RA	Least favourable	Most favourable
Risk	Skid resistance	Pf - performance	P	Average	Average	Average	Average		
		uncertainty		Medium	Low	Medium	High		
		Consequences (€)	N	150,000	150,000	150,000	150,000		
Cost	Capital Cost (€)		N		300,000	250,000	270,000		
CE	Proportion of recycled material (%)		N		0	20	50	0	100
Environmental	Carbon emissions (kg CO2/m2)		N		16	12	9	18	5
Social	Ride quality		P		0.25 - Minimum industry practice	0.25 - Minimum industry practice	0.25 - Minimum industry practice		

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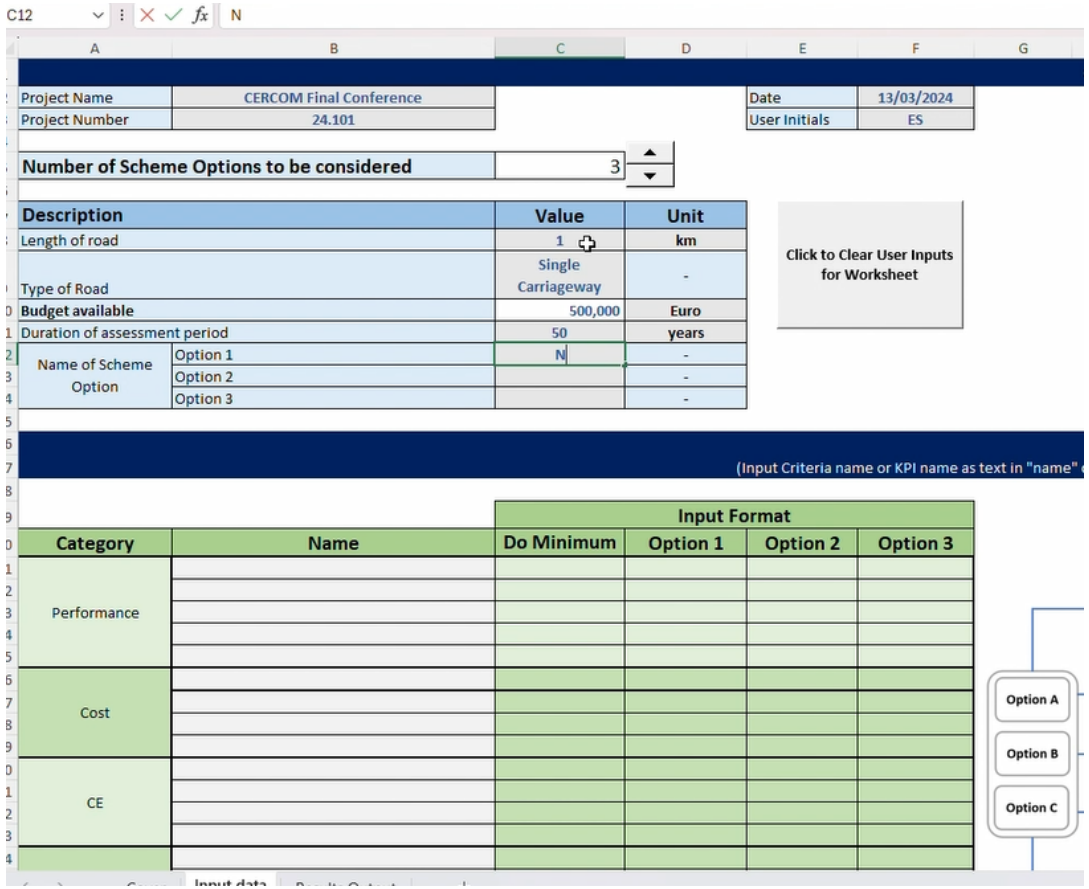

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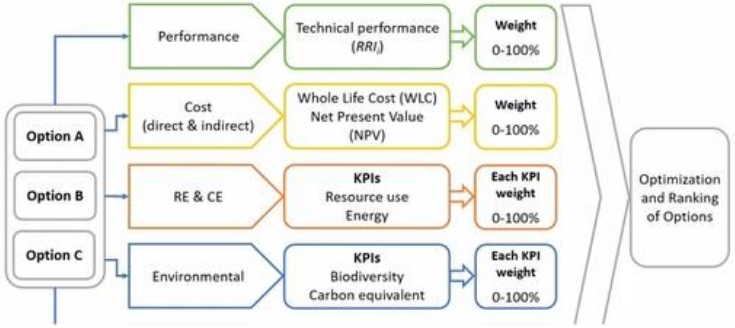
Input Categories and KPIs

(Input Criteria name or KPI name as text in "name" column and select input type in drop down menu for the number of options considered)

		Input Format			
Category	Name	Do Minimum	No RA	20% RA	50% RA
Performance	Skid Resistance	Preset scale	Preset scale	Preset scale	Preset scale
Cost	Cost (CPI)		Numerical Input	Numerical Input	Numerical Input
CE	Proportion of Recycled content		Numerical Input	Numerical Input	Numerical Input
Environment	Carbon Emissions		Numerical Input	Numerical Input	Numerical Input
Social	Ride Quality		Preset scale	Preset scale	Preset scale



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Input Values for Performance and Risk (Risk = Probability of Failure x Consequences)									
Risk	**Probability of Failure**					**Consequences (unit of currency)**			
Name	**Input**	**Do Minimum**	**No RA**	**20% RA**	**50% RA**	**Do Minimum**	**No RA**	**20% RA**	**50% RA**
Skid Resistance	Performance	Average	Average	Average	Average	150,000	150,000	150,000	150,000
	Uncertainty	Medium	Low	Medium	High				
	User - Numerical Input (between 0 and 1)								
	Performance								
	Uncertainty								
	User - Numerical Input (between 0 and 1)								
	Performance								
	Uncertainty								
	User - Numerical Input (between 0 and 1)								
	Performance								
	Uncertainty								
	User - Numerical Input (between 0 and 1)								
	Performance								
	Uncertainty								
	User - Numerical Input (between 0 and 1)								

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Input Value for Cost (for CPI calculation)

Not required if using NPV KPI to evaluate cost

Name	Unit	No RA	20% RA	50% RA
Cost (CPI)	Euro	300,000	250,000	270,000

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Input Data for KPIs and Ranked Interpolation																	
KPIs by Ranked Interpolation						Least Favourable Rank		Intermediate rank 1		Intermediate rank 2		Most Favourable Rank		No RA		
Category	KPI	KPI Number	Number Ranks	Interpolation Method	Unit	Data Value	KPI	Data Value	KPI	Data Value	KPI	Data Value	KPI	Data Value	KPI calc	Select
Cost		0		Linear												
				Linear												
				Linear												
CE	Proportion of Recycled content	1	2	Linear	%	0	0					100	1	0	0.00	
				Linear												
				Linear												
				Linear												
Environment	Carbon Emissions	2	2	Linear	kg CO2/m2	18	0					5	1	16	0.15	
				Linear												
				Linear												
				Linear												
Social	Ride Quality	3		Linear												
				Linear												
				Linear												
				Linear												

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Input Data for KPIs and Ranked Interpolation

Least Favourable Rank		Intermediate rank 1		Intermediate rank 2		Most Favourable Rank		No RA			20% RA			50% RA			
Data Value	KPI	Data Value	KPI	Data Value	KPI	Data Value	KPI	Data Value	KPI calc	Select KPI	Data Value	KPI calc	Select KPI	Data Value	KPI calc	Select KPI	
																	Clear
																	Clear
																	Clear
0	0					100	1	0	0.00		20	0.20		50	0.50		Clear
																	Clear
																	Clear
																	Clear
18	0					5	1	16	0.15		12	0.46		9	0.69		Clear
																	Clear
																	Clear
																	Clear
										0.25 - Minimum i			0.25 - Minimum i			0.25 - Minimum i	Clear
																	Clear
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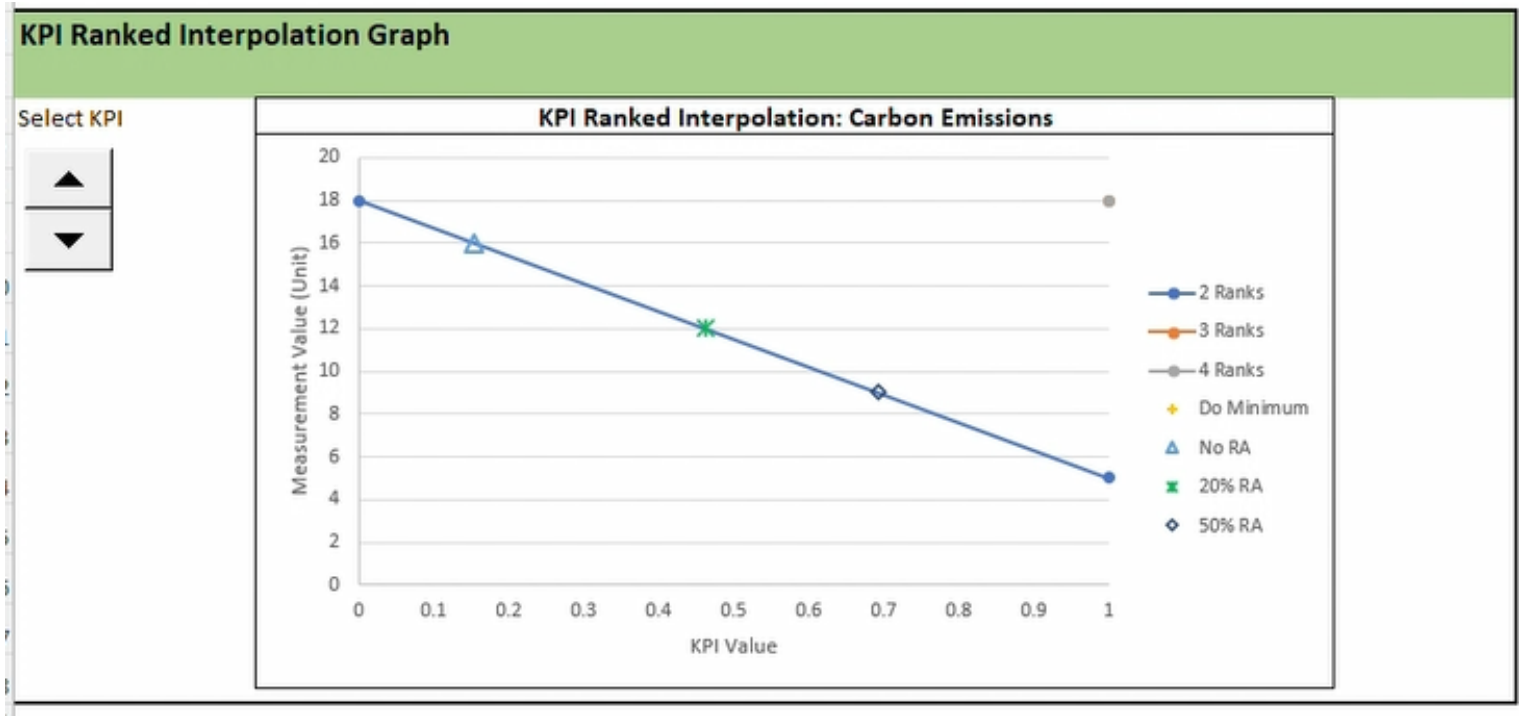

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Select Weights (Input weight in white boxes between 0 and 1.0 - Note: Sum of weights for each option must equal 1.0)				
Category	**Name**	**No RA**	**20% RA**	**50% RA**
Performance	Skid Resistance	0.3	0.3	0.3
Cost	Cost (CPI)	0.4		
CE	Proportion of Recycled content			
Environment	Carbon Emissions			
Social	Ride Quality			

ERROR - Sum of Weights for each option should equal to 1. Please revise input values.

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Select Weights
(Input weight in white boxes between 0 and 1.0 - Note: Sum of weights for each option must equal 1.0)

Category	Name	No RA	20% RA	50% RA
Performance	Skid Resistance	0.3	0.3	0.3
Cost	Cost (CPI)	0.4	0.4	0.4
CE	Proportion of Recycled content	0.1	0.1	0.1
Environment	Carbon Emissions	0.1	0.1	0.1
Social	Ride Quality	0.1	0.1	0.1

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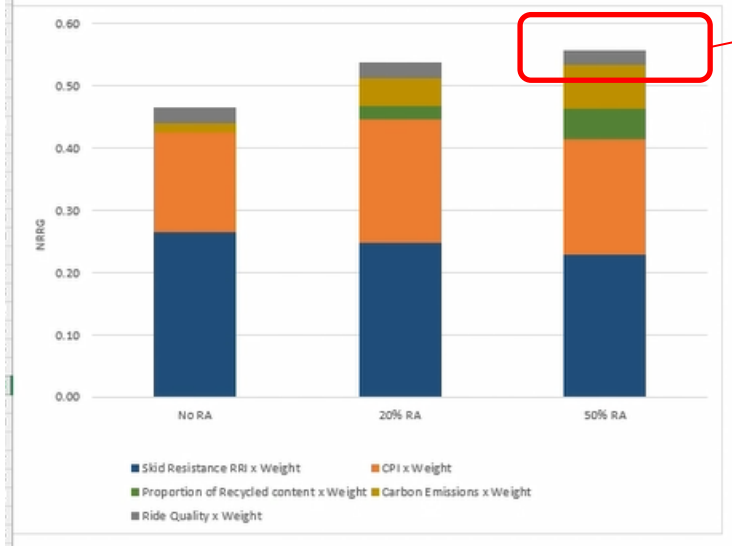
Results

Press Button for Updated Results

Product of Criteria/KPI and Weight

Category	Name	No RA	20% RA	50% RA
Performance	Skid Resistance RRI x Weight	0.26	0.25	0.23
Cost	CPI x Weight	0.16	0.20	0.18
CE	Proportion of Recycled content x Weight	0.00	0.02	0.05
Environment	Carbon Emissions x Weight	0.02	0.05	0.07
Social	Ride Quality x Weight	0.03	0.03	0.03
Net Risk Reduction Gain (NRRG)		0.47	0.54	0.56



Optimal solution

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Input Values for Performance and Risk
(Risk = Probability of Failure x Consequences)

Risk	Probability of Failure					Consequences (unit of currency)			
Name	Input	Do Minimum	No RA	20% RA	50% RA	Do Minimum	No RA	20% RA	50% RA
Skid Resistance	Performance	Average	Average	Average	Below Average	150,000	150,000	150,000	150,000
	Uncertainty	Medium	Low	Medium	High				
	User - Numerical Input (between 0 and 1)								
	Performance								

Updated inputs

Input Data for KPIs and Ranked Interpolation

Least Favourable Rank		Intermediate rank 1		Intermediate rank 2		Most Favourable Rank		No RA			20% RA			50% RA			
Data Value	KPI	Data Value	KPI	Data Value	KPI	Data Value	KPI	Data Value	KPI calc	Select KPI	Data Value	KPI calc	Select KPI	Data Value	KPI calc	Select KPI	
																	Clear
																	Clear
																	Clear
0	0					100	1	0	0.00		20	0.20		50	0.50		Clear
																	Clear
																	Clear
																	Clear
18	0					5	1	16	0.15		12	0.46		9	0.69		Clear
																	Clear
																	Clear
																	Clear
										0.25 - Minimum			0.25 - Minimum			0.10 - Below min	Clear
																	Clear
																	Clear
																	Clear

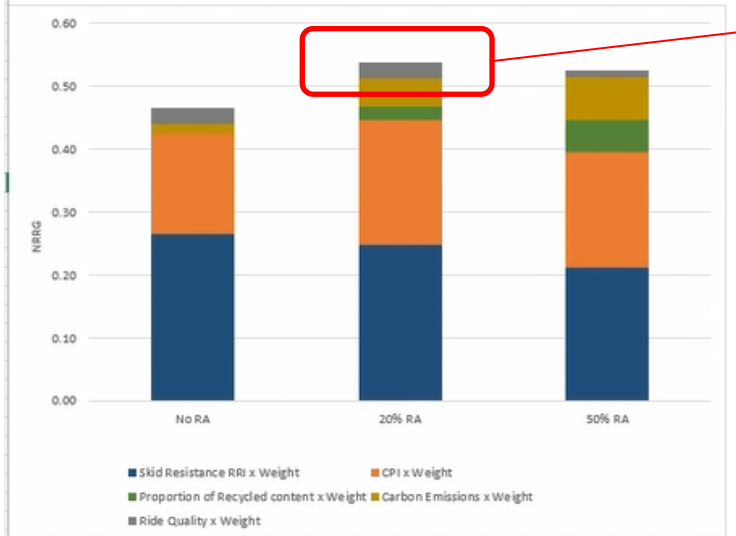
INTEGRATE VIDEO

Results

Press Button for Updated Results

Product of Criteria/KPI and Weight

Category	Name	No RA	20% RA	50% RA
Performance	Skid Resistance RRI x Weight	0.26	0.25	0.21
Cost	CPI x Weight	0.16	0.20	0.18
CE	Proportion of Recycled content x Weight	0.00	0.02	0.05
Environment	Carbon Emissions x Weight	0.02	0.05	0.07
Social	Ride Quality x Weight	0.03	0.03	0.01
Net Risk Reduction Gain (NRRG)		0.47	0.54	0.52



Optimal results following changes to input values

Thank you!

Any questions?