

Steps Toward The Achievement



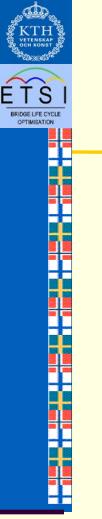


OPTIMISATION

Life Cycle Costs (Ideas and Remarks)

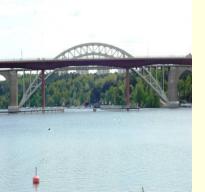
Safi Mohammed, MSc Student, Infrastructure Engineering, KTH Supervisors: Prof. Håkan Sundquist, KTH Dr. Hans-Åke Mattsson, KTH

Bridge Life Cycle Optimization, ETSI Stage 2, Closing Ship Seminar 17-18 March 2009



Points and outlines about ETSI

- Now we can say, we are only one step from culminating our progress by wearing the crown of ETSI which is: <u>A unified Nordic Methodology & Computer Program for</u> <u>Bridge LCC & LCA Estimation.</u>
- Many things and many interests for each parties, nothing is impossible.
- One great thing is the specifying of the requirements and the interests for each parties.



The ideas or the points that I am going to mentioned, may be right or not, all things are subjected to discussion and changes.



Three Main Steps to Reach the Main Goal of ETSI

- 1. Identification of the goals, parameters & assigning methodology for basic calculations (ETSI Stage1)
- 2. Detailed explanation of the interests and the considerations for each ETSI individuals (ETSI Stage2)
- 3. A- Creative ideas and models connecting and transforming the theoretical data and information into simple computer programs, say Excel sheets or others.



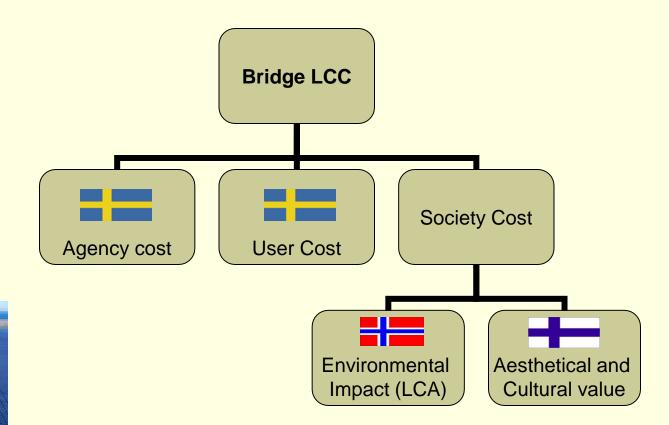
B- Upgrading and development of this simple programs and integrate them in a unified web based program.

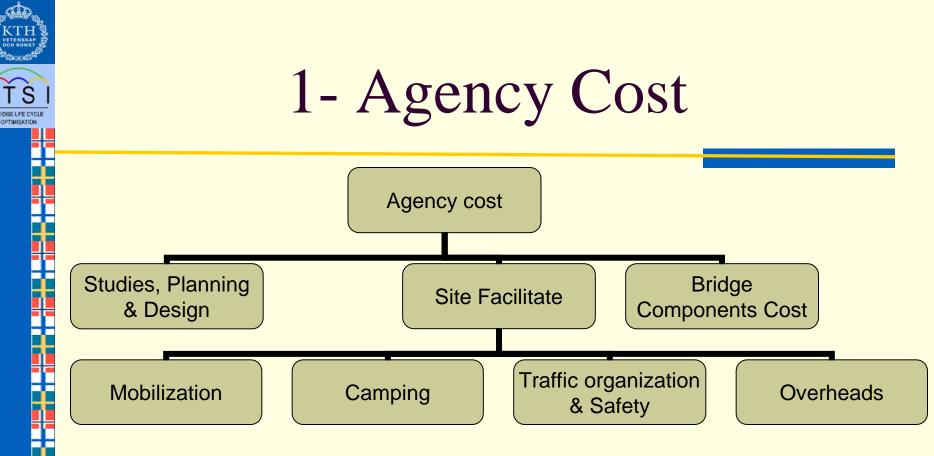




Step by Step, Tracking the Proposals Developments

Bridge life cycle cost components:-





Before going to the bridge components cost, Three things we have to unify:-



- Unified names of the actions that may take place during the structural element life
- Unified System for bridge components LCC analysis
- Unified degradation curves for bridge components.



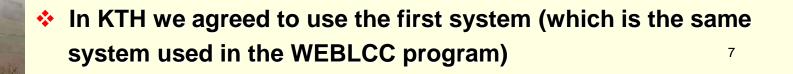
Structural Elements Life Cycle Actions

- Many names and titles with different words describing the action which could take place within the service life of the bridge components like:(investment, initial capital, purchasing and installation, reparation, repair, rehabilitation, operation, maintenance, inspection and investigation, demolition, replacement, and others)
 - We agreed in KTH to classify these actions ascending by its occurrence during the life cycle, with these proposed titles.
 - Investment (Purchasing & Installation) Cost
 - Operation & Maintenance Cost
 - Inspection Cost
 - Repair/Replacement & Rehabilitation Cost
 - End of life Management Cost



Two Possible Ways To Analyze The LCC of The Bridge Components.

By the action for all bridge components e.g., By the bridge component for all actions e.g., 1-Purchasing and installation cost **1-Substructure** Substructure Purchasing and installation cost Superstructure Operation & maintenance cost Bridge equipments Reparation & Rehabilitation cost Etc. Etc. 2-Superstructure 2-Operation & maintenance cost Substructure Purchasing and installation cost Operation & maintenance cost Superstructure Bridge equipments Reparation & Rehabilitation cost Etc. Etc... **3-Reparation & rehabilitation cost 3-Bridge Equipments** Substructure Purchasing and installation cost Superstructure Operation & maintenance cost Bridge equipments Reparation & Rehabilitation cost Etc. Etc. 4-Etc. 4-Etc. Etc Etc





Many proposals of breaking down the bridge

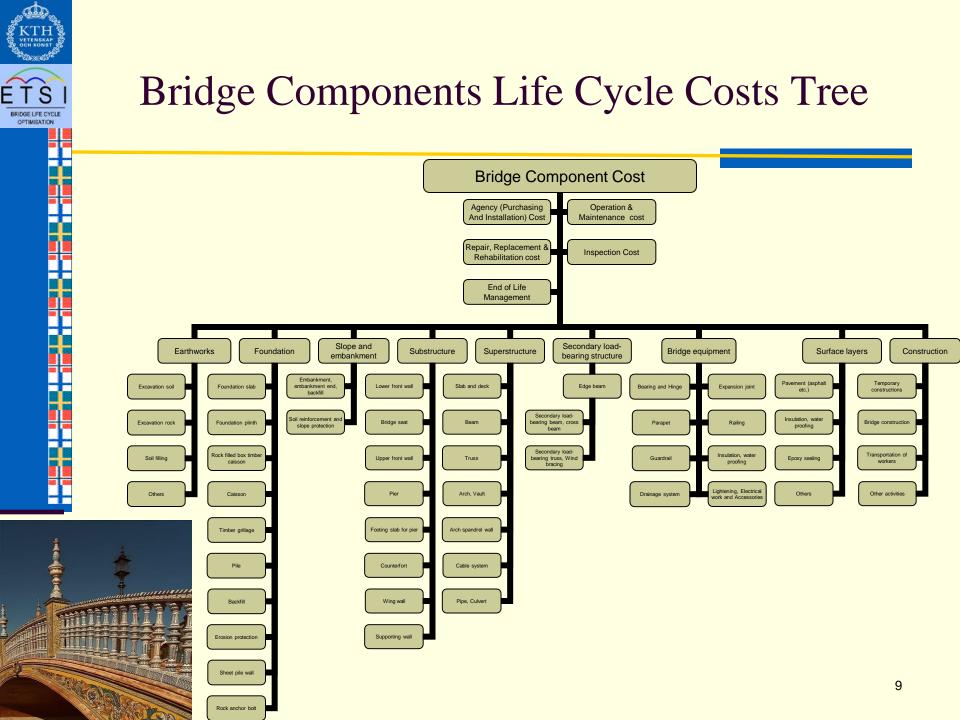
into components, which are as following:-

- A- LCA group proposal
- **B-** 3 proposals from Håkan Sundquist
- C- 1 proposal from Arne Juttila
- What is the main requirement from the unified proposal?
 - Include the LCA required parameters within the parameters of LCC calculation. So in this case we don't have to import any external Excel sheets to LCCWEB program to calculate LCA



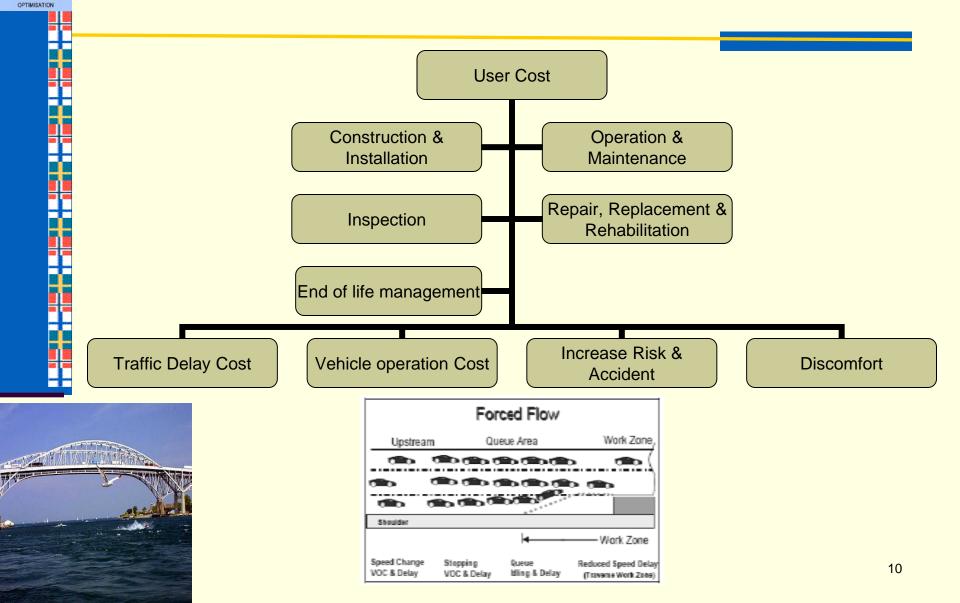
In KTH, we achieve this target by preparing a proposal which include all of the required parameters in LCC & LCA (and now we are working with creating a model for this purpose)

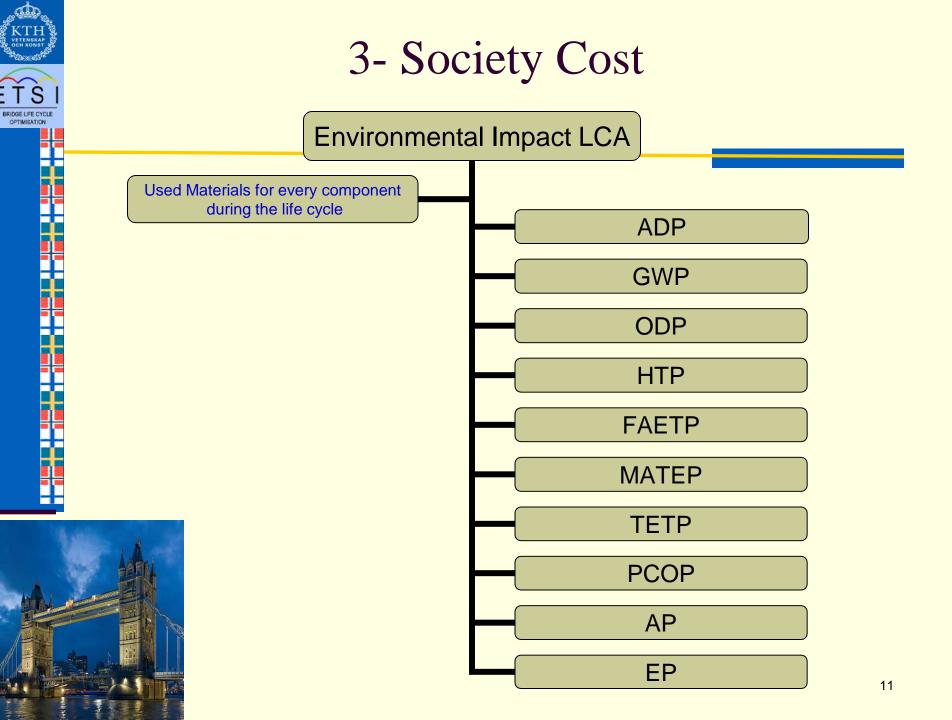
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Foat transportation [km]						Boat transportation [km]
Ship transportation [km]						Ship transportation [km]
Train transportation [km]						Train transportation [km]
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	-			1.2 excaration rock		Excavation rock
				1.2 soil filing		Sod filing
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	Caisson	File	Excevation, rock			Caircon
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	Pile Backfill		Erosion protection			File Backfil
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	Sheet pile wall					Sheet pile wall
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	Pale cap			7.5 pavement (asphalt	etc)	
	Pile deck			7.6 others		
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					support	
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					piers)	
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	Wing wal					Wing wall
	Supporting wall					Supporting wall
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Slab and deck	Slab	Slab / deck	Slab and deck	4.1 main load carrying	3.1 Main load carr	Slab and deck
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Arch Mark						
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2- User Costs

BRIDGE LIFE CYCLE







An effective model combining the agency costs, the user costs & LCA impact at the same time

	Investment (Purchasing & Installation) Cost										
Bridge Component, Activites			Used M	aterials		N	User Cost		Other		
		Blasting [kg]	[▼ R Add	Quantity	Truck transportation 💌	Distance [km]	Weight [ton],[person]	Days of Work	Affected Length (Km)	Total Price
1-Foundation		-				Truck transportation					
Caisson 🔽 🗖 Add											
2-Slope and embankment											
Embankment, embankment end, backfill 💽 🗖 Add											
3-Substructure											
Bridge seat											
4-Superstructure											
Arch, Vault 🔽 🗖 Add											
5-Secondary load-bearing structure											
Edge beam											
6-Bridge equipment											
Raling Add											
7-Surfacelayers											
Others Add											
8. Earthworks											
Excavation soil											
9. Construction											
Transportation of workers											
10. End of Life Management											
7.3 Waste management (incl. recycling and recovery) 🔽 🗖 Add											
I Add			0		D.f	Cost.					
					² Mainte	enance Cost	laterial Transpor	tation	User	Cost	Other
Bridge Component, Activites		Blasting [kg]	Oper Used M			N	Iaterial Transpor Distance [km]		User Days of Work	Affected	Other Total
Bridge Component, Activites		Blasting [kg]		aterials	<mark>Quantity</mark>	Truck transportation	Interial Transpor	tation Weight (ton),[person]	User Days of Work		
Bridge Component, Activites 1-Foundation		Blasting [kg]		aterials		N				Affected	Total
Bridge Component, Activites 1-Foundation Casson		Blasting [kg]		aterials		Truck transportation				Affected	Total
Bridge Component, Activites 1-Foundation Caisson Caisson Caisson Caisson Caisson		Blasting [kg]		aterials		Truck transportation				Affected	Total
Bridge Component, Activites 1-Foundation Casson		Blasting [kg]		aterials		Truck transportation				Affected	Total
Bridge Component, Activites 1-Foundation Cascon Ca		Blasting (kg)		aterials		Truck transportation				Affected	Total
Bridge Component, Activites 1-Foundation Casson Cason Casson Casson Casson Casson Caso		Blasting [kg]		aterials		Truck transportation				Affected	Total
Bridge Component, Activites 1-Foundation Caeson Ca		Blasting [kg]		aterials		Truck transportation				Affected	Total
Bridge Component, Activities I-Foundation Cascon C		Blasting (kg)		aterials		Truck transportation				Affected	Total
Bridge Component, Activities I-Foundation Casson		Blasting (kg)		aterials		Truck transportation				Affected	Total
Bridge Component, Activities I-Foundation Cateson Cateson Cateson Cateson Cateson Cateson Category C		Blasting (kg)		aterials		Truck transportation				Affected	Total
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Eridge Component, Activites I-Foundation Casson Cason Casson Casson Casson Casson Caso		Biasting [kg]		aterials		Truck transportation				Affected	Total
Bridge Component, Activities I-Foundation Casson		55asting [kg]		aterials		Truck transportation				Affected	Total
Bridge Component, Activities I-Foundation Casson Cason Casson Casson Casson Casson Cas		Blasting (kg)		aterials		Truck transportation				Affected	Total
Bridge Component, Activities I-Foundation Casson		Elasting [kg]		aterials		Truck transportation				Affected	Total
Bridge Component, Activities I-Foundation Cateson Cateson Cateson Cateson Cateson Cateson Cateson Categories		Blasting [kg]		aterials		Truck transportation				Affected	Total



Repair/Replacement & Rehabilitation Cost

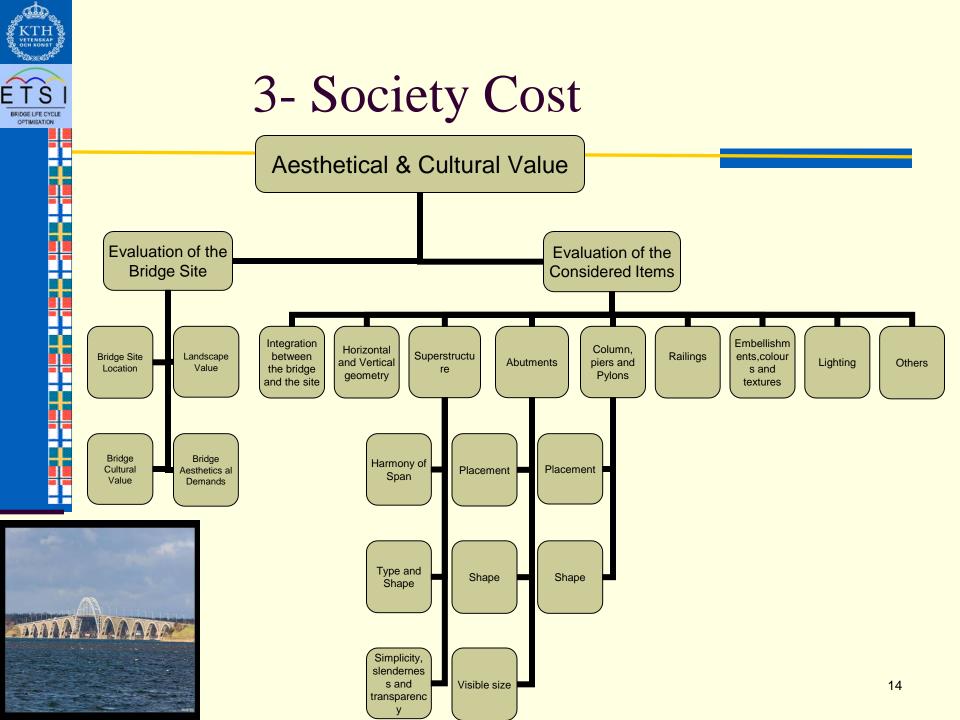


An effective model combining the agency costs, the user costs & LCA impact at the same time

- With doing some updates and little changes in the WEBLCC model we can include LCA, as proposed in the next slide.
 - Including the used materials in LCA model by a build up list of material.
 - Perfectly specifying the transportation of each bridge component
 - Using the used material column we can compute the prices for LCC and the amounts for LCA









SP3 Unique, Systematic Way for Evaluating the Aesthetical Value of the Bridge

We tried to convert this theoretical system into a simple Excel program and applied this to some cases.

Then we have found some questions that need to be clarified.

$$C_{rel} = k_{rel} C_{LCC} \qquad \qquad C = C_{rel} + C_{LCA}$$

Where is the user cost?!



At A mark	AES	THETICS AN	D CULI	TUF	CAL VALUE	OF THE BR	DGE		21
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issumption, a –	0.2				ases the reduction		alles Detweell .	0.8 allu	1.2
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			Class		Explanation				
			Class I		Very demanding				
			Class II		Demanding				
			Class III		Remarkable				
			Class IV		Ordinary				
Evaluated ite		University	. 1		Chiltranitanation	Caller And data sites	A successful to the second second		1
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			Louinun		i Druge nen				
			Categor	у	Explanation				
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			-1		Modest				
			0		Medium				
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					Excellent				
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	placement		-2	•	2	1	1	0	
Abutments	shape		-2	•	1	1	1	0	
	visible size		-2	_	1	1	1	0	
Columns, piers	placement		-2	_	1 3	1 2	1	0	
and pylons ailings	shape		-2 -2	 ▼	2	2	1	0	
-	urface colors and	d textures	-2	- -	2	2	1	0	
ighting			-2	•	2	2	1	0	
thers			-2	-	0	0	0	0	
			Σ		32	25	15	0	
			K _{rel} -	-	1.156				

(rel max

Kast min

1.2

0.8

1.156

0.844

1.094

0.906



SP3 Unique, Systematic Way for Evaluating the Aesthetical Value of the Bridge

questions need to be clarified.

$$k_{rel} = 1 - a \frac{\sum_{i=1}^{n} w_i p_i}{p_{\max} \sum_{i=1}^{n} w_i} = 1 - 0, 2 \frac{\sum_{i=1}^{n} w_i p_i}{2 \sum_{i=1}^{n} w_i} = 1 - 0, 1 \frac{\sum_{i=1}^{n} w_i p_i}{\sum_{i=1}^{n} w_i}$$

	AES	THETICS AN	D CULT	UF	AL VALUE	OF THE BRI	DGE		
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			Class		Explanation				
			Class I		Very demanding				
			Class II		Demanding				
			Class III		Remarkable				
			Class IV		Ordinary				
Evaluated ite									
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			Category		Explanation				
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			-1		Modest Medium				
			1		Good				
			2		Excellent				
Cor	aidoned Iter		Evaluation		Proposed	l weight factors	for the conside	ered items	
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Abutments	shape		-2	$\overline{\bullet}$	1	1	1	0	
	visible size		-2		1	1	1	0	
Columns, piers	placement		-2		1	1	1	0	
and pylons	shape		-2		3	2	1	0	
Railings Embellishments, sı	inface colors and	1 textures	-2	┛	2	2	1	0	
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Others			-2	J	0	0	0	0	
			Σ	_	32	25	15	0	
			K _{rel} =		1.156				
	1							ı I	

a=.2	Class I	Class II	Class III	Class IV
K _{rel} max	1.2	1.2	1.2	1.2
K _{rel} min	0.8	0.8	0.8	0.8



Two Possible Ways to Include & Assess the Bridge Environmental Impacts (LCA)

1- By transforming the amount of emissions & the environment distortion due to the usage of unrenewable materials from

Unit Quantity to Unified Standard Unit Price. eg.

- A unit of Global Warming Potential (GWP) will cost me (xxx \$)
- * and then add this prices of the emissions to LCC cost.
- (May this is not applicable due to differences in the environmental policy).
- 2- Follow the suggestions which was mentioned in SP3 with same procedures with little changes to concise the demand of the environments



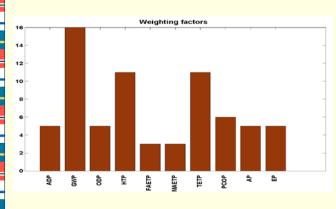
 (Need help from the Norwegian team to propose the parameters to be considered and its weight factors)

A model suggesting how to include and translate LCA–values into LCC calculations will be presented in the next slide

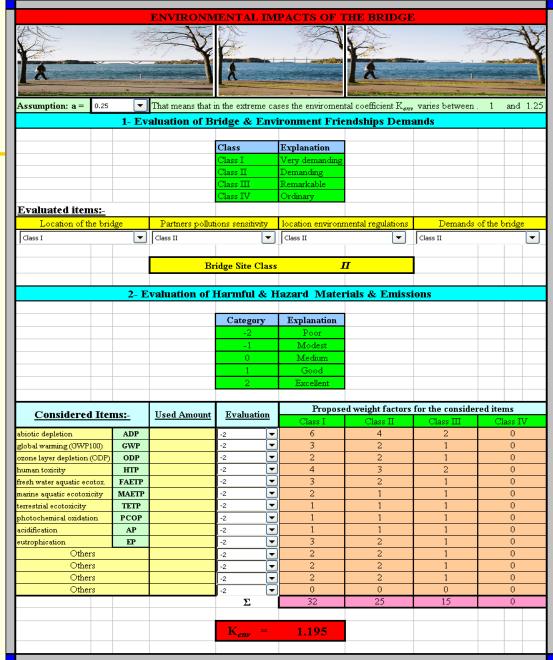


OPTIMISATION

Proposed Model to include LCA in LCC calculations



Need adoption and confirmation from the Norwegian team



a=.2	Class I	Class II	Class III	Class IV				
K _{env}	1.2	1.156	1.094	1				
Kenny must be bigger than one for all cases								

Thank You

Questions?