Indicators and Benchmarking

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Why indicators

- Optimizing building sustainability involves various relations between built, natural and social systems. Therefore it comprises **hundreds of parameters,** most of them interrelated and partly contradictory.

- This way, sustainability assessment process is only possible through a **systematic approach**.

- Sustainability assessment tools are useful to **gather** and **report** information for **decision-making** during different phases of construction, design and use of a building (holistic approach).

➢ Therefore sustainable assessment is generally based on a **list of indicators**.

*A sustainability **indicator** should*:

- **provide information about the main influences** of the industry as a whole and about the impacts of construction and operation of buildings and other built assets;
- **be expressed by a value derived from a combination of different measurable parameters** (variables)

➢ **Different Indicators have been developed** by institutions, organizations and industries locally, nationally and globally.

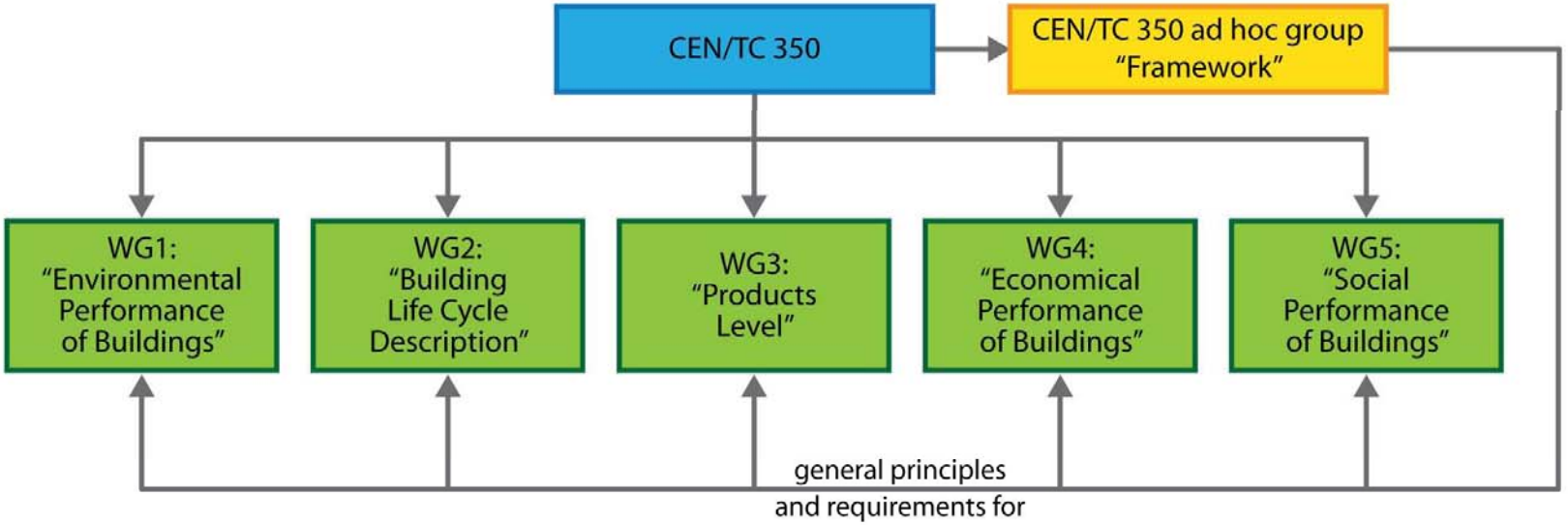
Main reasons…

- Political, Technological and Cultural differences between countries;
- Lack of normalization and common understanding.

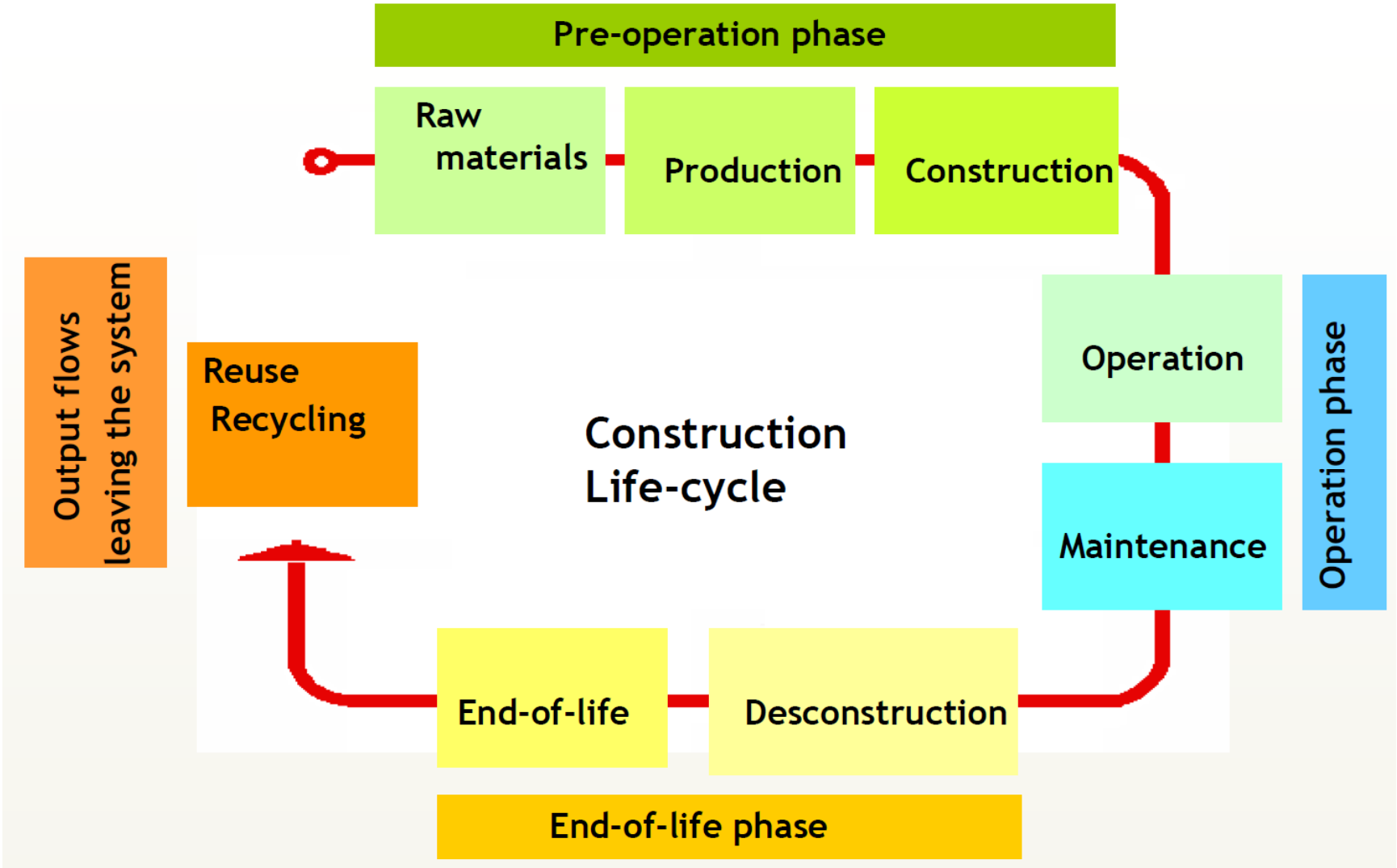
Different indicators (methods) = **Different results**

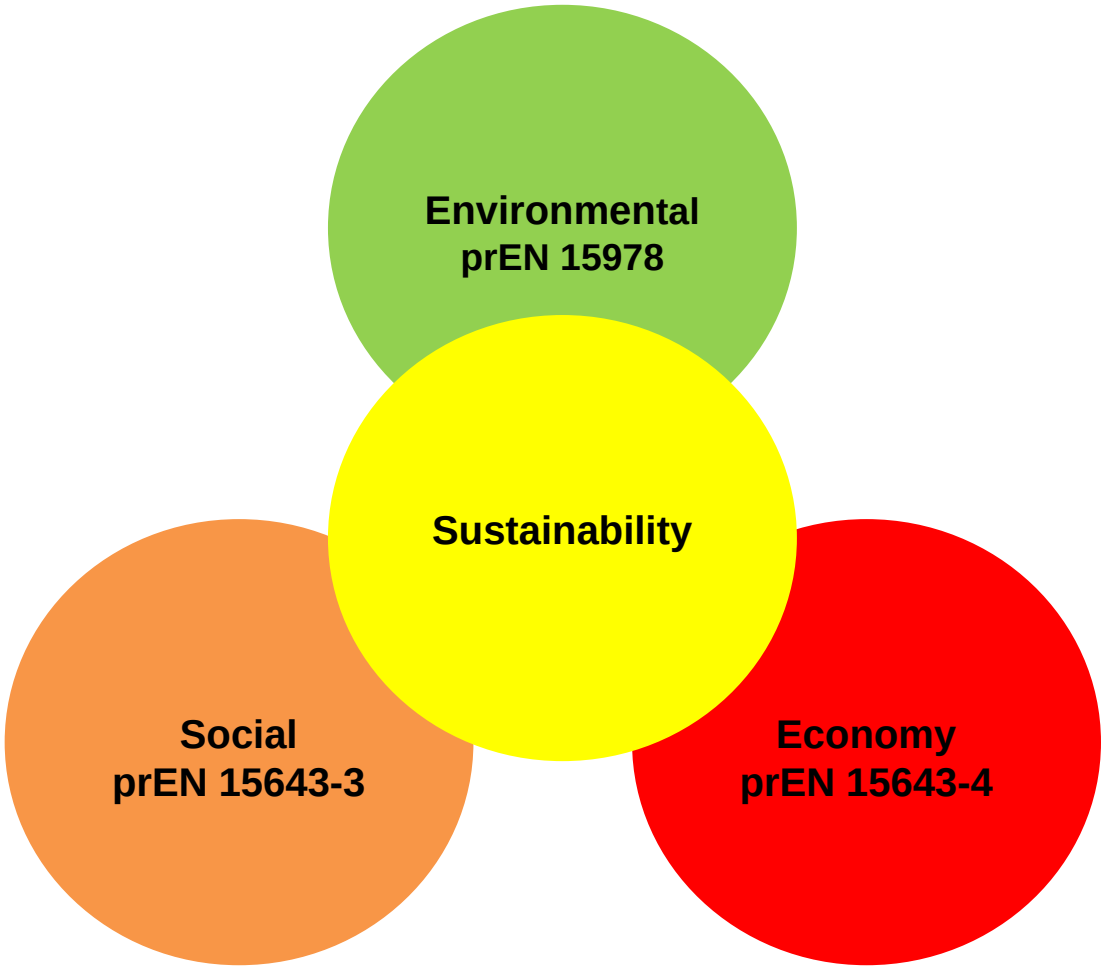
Development of sustainability assessment systems

- In order to **standardize** and **promote** the **interpretation and comparison of results** from different assessment methods developed in Europe, the European Committee for Standardization (CEN) launched the Technical Committee 350 (CEN/TC 350).



Life-cycle boundaries




Environmental
prEN 15978
Sustainability
Social
prEN 15643-3
Economy
prEN 15643-4

Environment
prEN 15978

- According to standard **prEN 15978:2011** the assessment of the environmental performance of a building is based in **4 types of environmental indicators** (**total of 22**):

1 - Indicators describing environmental impacts:

Indicator	Unit
Global warming potential, GWP	kg CO_2 equiv
Depletion potential of the stratospheric ozone layer, ODP;	kg CFC 11 equiv
Acidification potential of land and water; AP;	kg SO_2^{-} equiv
Eutrophication potential, EP;	kg $(PO_4)^{3-}$ equiv
Formation potential of tropospheric ozone photochemical oxidants, POCP;	kg Ethene equiv
Abiotic Resource Depletion Potential for elements; ADP_elements	kg Sb equiv
Abiotic Resource Depletion Potential of fossil fuels ADP_fossil fuels	MJ

Environment
prEN 15978

2 - Indicators describing resource use:

Indicator	Unit
Use of renewable primary energy excluding energy resources used as raw material	MJ, net calorific value
Use of renewable primary energy resources used as raw material	MJ, net calorific value
Use of non-renewable primary energy excluding primary energy resources used as raw material	MJ, net calorific value
Use of non-renewable primary energy resources used as raw material	MJ, net calorific value
Use of secondary material	kg
Use of renewable secondary fuels	MJ
Use of non-renewable secondary fuels	MJ
Use of net fresh water	m^3

Environment
prEN 15978

3 - Indicators describing additional environmental information:

Indicator	Unit
Hazardous waste disposed;	kg
Non-hazardous waste disposed	kg
Radioactive waste disposed	kg

4 - Indicators describing the output flows leaving the system:

Indicator	Unit
Components for re-use	kg
Materials for recycling	kg
Materials for energy recovery (not being waste incineration)	kg
Exported energy	MJ for each energy carrier

Social
prEN 15643-3

➢ Some of the established **social indicators** are:

Indicators describing social impacts:

- Accessibility ;
- Adaptability /flexibility;
- Health and comfort;
- Cultural identity;
- Neighborhood pressure;
- Maintenance;
- Safety/security.

Economy
prEN 15643-4

➢ Economy aspects should **include life-cycle costs related to**:

- Operation;
- Maintnance;
- Refurnishing and replacement of components;
- Desconstruction;
- Recycling/end-of-life scenario.

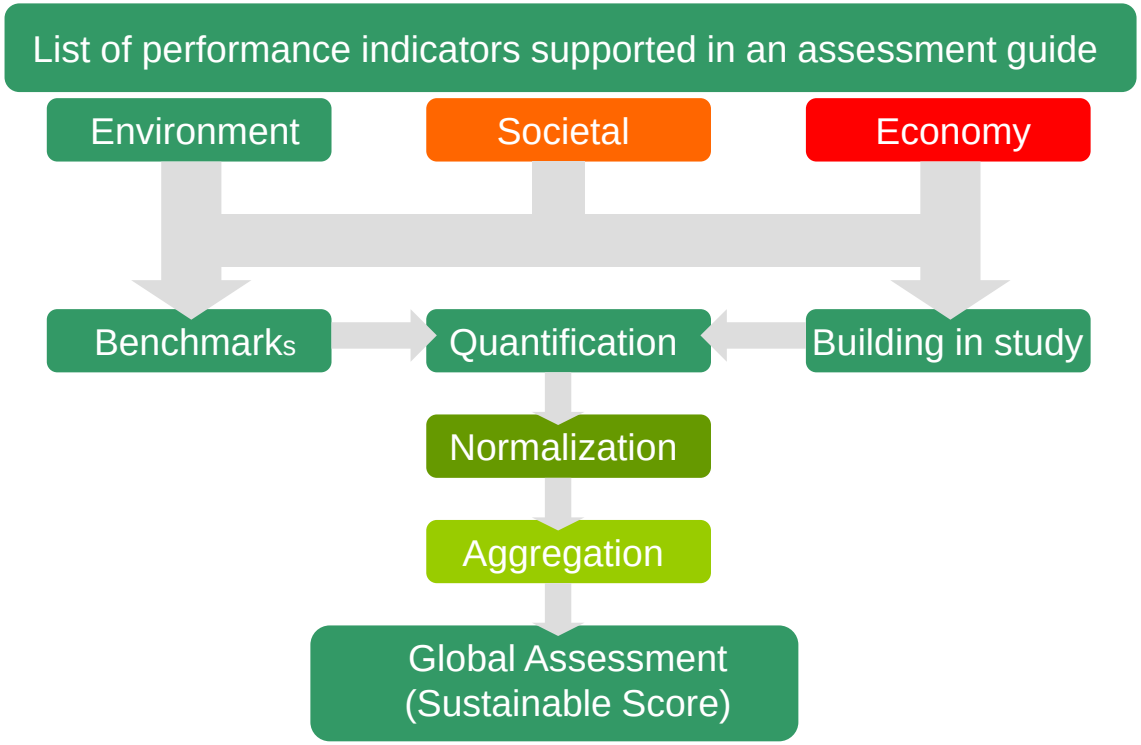
Use of CEN/TC 350 indicators on BSA methods

(example of SBTool^{PT}-H)

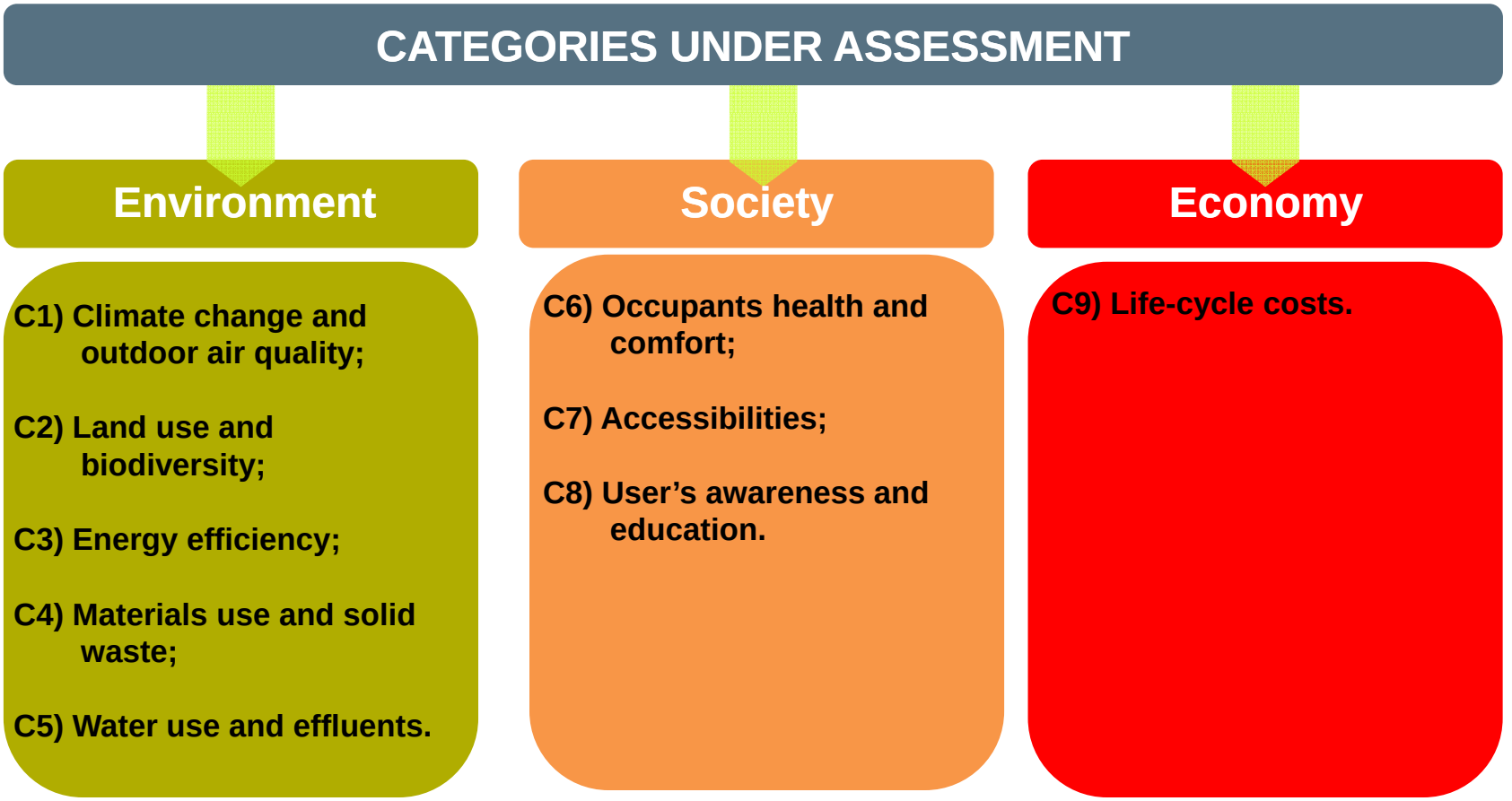
- Based on global methodology SBTool and on the ongoing work in CEN/TC 350, there are in development a series of sustainability assessment and certification tools that are appropriate to the national contexts (standards and regulations, weather, technologies and sociocultural issues).

Step 1: Module for assessment of residential buildings (SBTool^{PT}– H)

STRUCTURE OF THE METHODOLOGY SBTool^{PT} - H



DIMENSIONS, CATEGORIES E PARAMETERS



Categories and environmental parameters (15)

Dimension	Categories	Parameters	P_{ID}
DA - Environmental	C1 – Climate change and outdoor air quality	• Embodied environmental impacts	P1
	C2 – Land use and biodiversity	• Urban soil use	P2
		• Land waterproofed index	P3
		• Pre-developed land use	P4
		• Use of local plants	P5
		• Heat-island effect	P6

Categories and environmental parameters (cont.)

Dimensão	Categorias	Parâmetros	P_{ID}
DA – Environmental	C3 - Energy Efficiency	• Primary energy consumption	P7
		• In-situ energy production from renewables	P8
	C4 – Materials and solid waste	• Building materials re-use	P9
		• Building materials recycling content	P10
		• Use of certified organic materials	P11
		• Use of cement substitutes materials on concrete	P12
		• Household waste management	P13
	C5 – Water efficiency and effluents	• Fresh water consumption	P14
		• Water reuse and recycling	P15

Categories and societal parameters (8)

Dimension	Categories	Parameters	P_{ID}
DS – Societal	C6 – Occupant's health and comfort	• Natural ventilation potential	P16
		• Embodied VOC content	P17
		• Thermal comfort	P18
		• Natural lighting potential	P19
		• Acoustic comfort	P20
	C7 - Accessibilities	• Acessibility to public transportation	P21
		• Acessibilities to urban amenities	P22
	C8 – Users education and awareness	• Availability and content of the Building User's Manual	P23

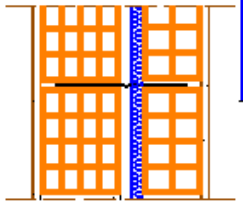
Categories and economic parameters (2)

Dimension	Categories	Parameters	P_{ID}
DE -Economy	▪ Life-cycle cost	• Capital costs	P24
		• Operation costs	P25

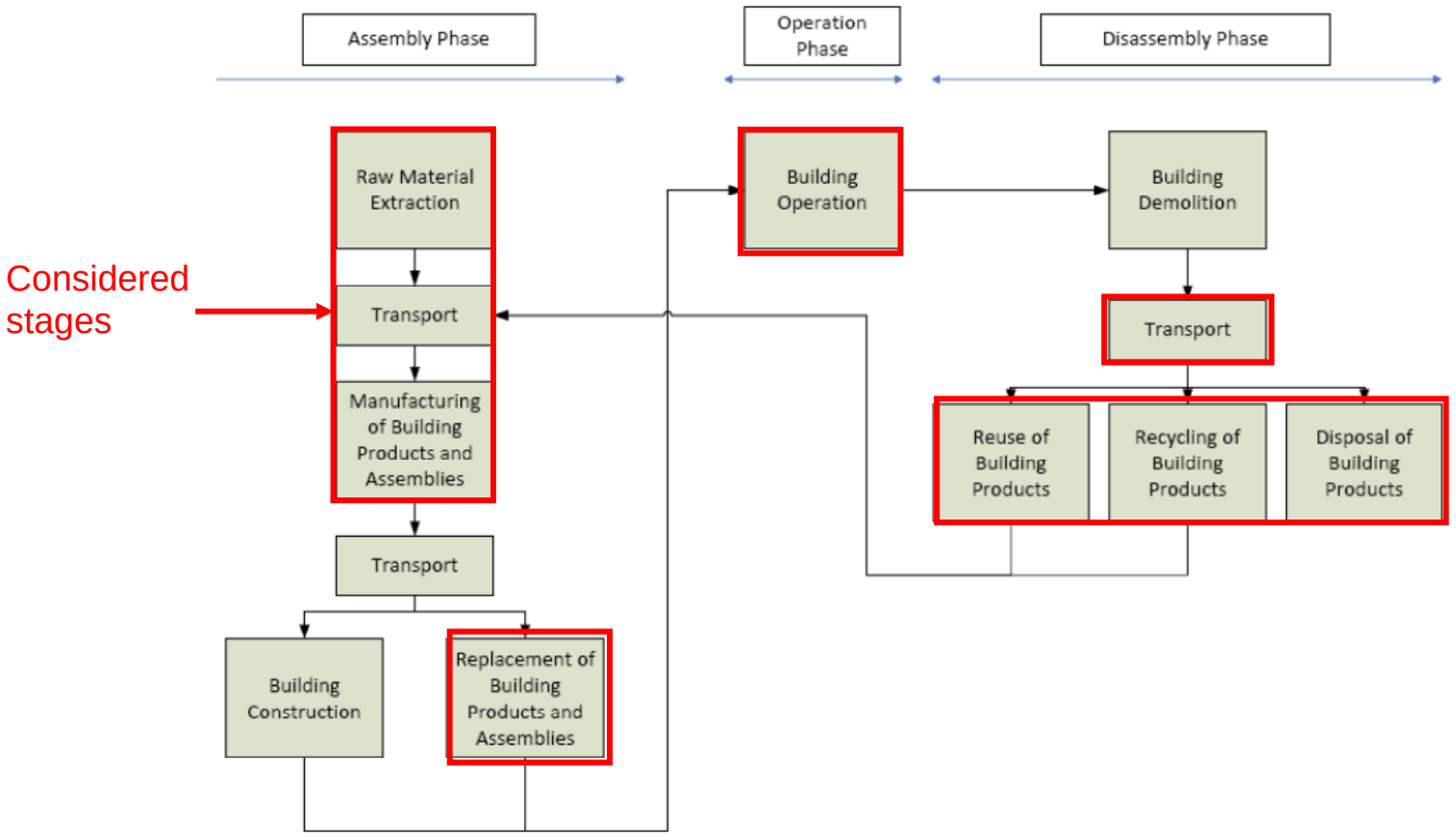
QUANTIFICATION OF PARAMETERS

➢ ENVIRONMENTAL

LCA database (example)

Solução construtiva	**Parede dupla de alvenaria de tijolo furado (15cm+11cm) com isolamento térmico em EPS na caixa-de-ar**							**Ref: Par 1**
	**Fase de ciclo de vida**	**Categorias de impacte ambiental de LCA**						**Energia incorporada**	
		ADP	GWP	ODP	AP	POCP	EP	ENR	ER
	Cradle-to-gate	3.70E-01	9.53E+01	1.02E-04	1.91E-01	1.13E-02	2.54E-02	8.68E+02	1.01E+02
	Fim de vida	2.08E-01	3.17E+01	5.00E-06	1.42E-01	5.40E-03	2.95E-02	4.75E+02	2.83E+00
	Total	5.78E-01	1.27E+02	1.07E-04	3.33E-01	1.67E-02	5.49E-02	1.34E+03	1.04E+02
	Comentários:	**Materiais Considerados:** Tijolo furado, poliestireno expandido extrudido (isolamento térmico), argamassa de assentamento e reboco (revestimento) **Método(s) de LCA:** CML 2 baseline 2000 versão 2.04 (para avaliar o Impacto ambiental) e Cumulative Energy Demand versão 1.04 (Para avaliar a energia) **Bibliotecas do LCI:** Ecoinvent system process							

Typical life-cycle of a building and **considered stages**.



SOCIETAL

Using one of the different **analytical methods** or **through experimental monitoring.**

ECONOMIC

Using costs databases or through the use of external **Life-cycle costing (LCC) tools.**

Why Benchmarking?

NORMALIZATION OF PARAMETERS/BENCHMARKING

Relevance of benchmarking:

- **systematic process** for identifying and implementing **best or better practices**;
- **sustainability is a relative matter** and therefore the performance of a building under assessment should be compared with conventional and best/better practices (benchmarks).

➢ On SBTool, the adopted benchmarking process **compares the performance of a building with conventional and better practices**.

- On SBTool^{PT} the following principles were used to set the benchmarks of the 25 indicators:

  - **Conventional practice –** a building with the same geometry as the one under assessment but that uses the local's conventional building elements (for the embodied impacts) & that fulfills the minimum environmental legal requirements or that has a similar performance to the conventional practice (other indicators).
  - **Best/better practice –** a building that have 25% of the conventional impacts (for the embodied impacts) & that fulfils best/better practices (other indicators)

- The adopted normalization system, converts the performance values obtained for each parameter on a scale between **0 (reference value /conventional) and 1 (best/better performance):**

$$\overline{P_i} = \frac{P_i - P_{*i}}{P_i^* - P_{*i}} \forall_i$$

with,
P_i – Value of *i*th parameter;
P_{*i} – Conventional practice of *i*th parameter ;
P^*_i – Best practice of the *i*th parameter.

- The quantified values are converted in a **graded scale, from A+ to E**:

Best practice

Conventional practice

A+	$\overline{P} > 1{,}00$
A	$0{,}70 < \overline{P} \leq 1{,}00$
B	$0{,}40 < \overline{P} \leq 0{,}70$
C	$0{,}10 < \overline{P} \leq 0{,}40$
D	$0{,}00 \leq \overline{P} \leq 0{,}10$
E	$0{,}00 < \overline{P}$

PARAMETERS AGREGATION - WEIGHTS

➢Environmental (US EPA's TRACI method)

Table 1: Relative importance of each environmental impact according to EPA,U.S.A.

ID	Categorias de impacte ambiental	Pesos (%)
GWP	Potencial de Aquecimento Global	16
AP	Potencial de Acidificação	5
EP	Potencial de Eutrofização	5
FFDP	Potencial de Esgotamento das Reservas de Combustíveis Fósseis	5
IAQ	Qualidade do Ar Interior	11
HA	Alteração dos Habitats	16
WI	Consumo de Água	3
CAP	Poluição da Atmosfera	6
POCP	Potencial de Oxidação Fotoquímica (smog)	6
ODP	Potencial de Destruição da Camada de Ozono	5
ET	Toxicidade Ecológica	11
HT	Toxicidade Para o Ser Humano	11

- **The weights of the environmental parameters considered in SBTool^{PT}** result from the distribution of the weights of the environmental categories of TRACI method (extent, intensity and duration of impact).

PARAMETERS AGREGATION - WEIGHTS (cont.)

- **Social**

A **scientific based methodology** was developed to quantify the relative importance of each comfort and health parameter in global comfort perceived for building occupants.

The perceived global comfort (C_G) result from the combination of various comfort parameters (P_i):

$$C_G = P_1 \times W_1 + P_2 \times W_2 + P_3 \times W_3 + P4 \times W_4$$

Each parameter affects differently the global comfort, since it presents a different **subjective weight (W_i).**

PARAMETERS AGREGATION – WEIGHTS (cont.)

Methodology

Subjective Evaluation

Thermal Comfort

Visual Comfort

Acoustics

Air Quality

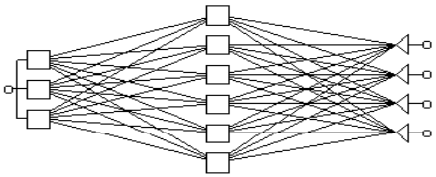
Conforto Global

Weight:

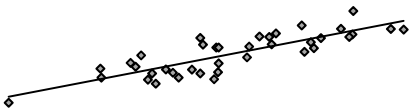
Thermal Comfort:32,5%
Visual Comfort: 24,6%
Indoor Air Quality: 23,8%
Acoustics: 19,1%

Objective Evaluation

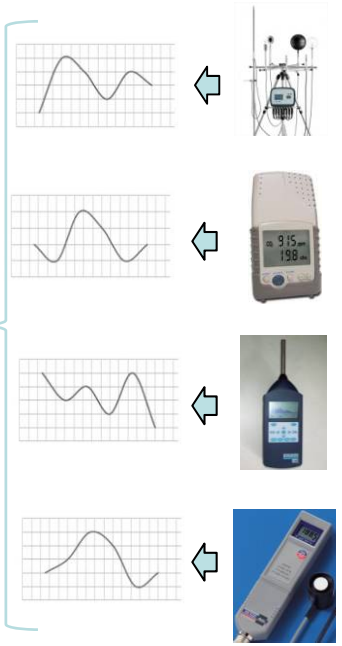
Neural Networks



Multivariate Regression – Linear Regression



Results: W_1, W_2, W_3, W_4



WEIGHTS (Categories)

Dimension	Category		Weight (%)
Environmental	C1	Climate change and outdoor air quality	13
	C2	Land use and biodiversity	20
	C3	Energy efficiency	32
	C4	Materials and waste management	29
	C5	Water efficiency	6
Societal	C6	Occupant's health and comfort	60
	C7	Accessibilities	30
	C8	Awareness and education for sustainability	10
Economy	C9	Life-cycle costs	100

WEIGHTS (Sustainability dimensions)

Dimension		Weight (%)
Environmental	DA	40
Societal	DS	30
Economy	DE	30

REPRESENTATION AND GLOBAL ASSESSMENT OF A PROJECT

➢ **The assessment output is presented at two levels:**

Level 1: Categories

Figure 2: **SBTool^{PT}**-H output for a hypothetical building - performance of the solution presented at the level of the different categories.

REPRESENTATION AND GLOBAL ASSESSMENT OF A PROJECT (cont.)

Level 2: Sustainable dimensions and sustainable score

- The assessment output is similar to the approach adopted by existing schemes such as EU Energy labelling scheme for white goods and European Display™ Campaign posters.

Figure 3: Performance of the solution at the level of each dimension and overall score

Certificado
de Sustentablidade

Nº Certificado

SBTOOL pt
ferramenta para a construção sustentável

1 - IDENTIFICAÇÃO DO EDIFÍCIO

Foto (alçado principal)

TIPO ○ Edif. Habitação Unifamiliar ○ Edif. Habitação Multifamiliar

MORADA / SITUAÇÃO

Rua/Avenida/Praça	
Localidade	Freguesia
Concelho	Código Postal -
Imóvel inscrito na	Cons. do Reg. Predial de
Sob o nº	Art. Matricial nº

2 - ETIQUETA DE SUSTENTABILIDADE

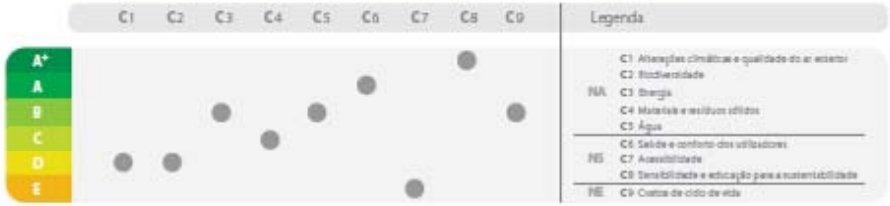
Desempenho ao nível de cada dimensão
Nota Global (NG)

Legenda da ferramenta SBTOOL pt

NG	NA	NS	NE
Nota Global	Nota Ambiental	Nota Social	Nota Económica
	- Alterações climáticas e qualidade do ar exterior - Biodiversidade - Energia - Materiais e resíduos sólidos - Água	- Saúde e conforto dos utilizadores - Acessibilidade - Sensibilidade e educação para a sustentabilidade	- Custos de ciclo de vida

NG
Nota Global

3 - DESAGREGAÇÃO DO DESEMPENHO POR CADA CATEGORIA



Legenda

NA	C1 Alterações climáticas e qualidade do ar exterior
	C2 Biodiversidade
	C3 Energia
	C4 Materiais e resíduos sólidos
	C5 Água
NS	C6 Saúde e conforto dos utilizadores
	C7 Acessibilidade
	C8 Sensibilidade e educação para a sustentabilidade
NE	C9 Custos de ciclo de vida

Nome do responsável pela emissão do certificado

Avaliador

Data de emissão

ENTIDADE SUPERVISORA

iiSBE PORTUGAL
International Initiative for a Sustainable Built Environment

To discuss

1. How much effort (working time and/or cost) is reasonable to ask for a sustainability assessment in relation to the total building design effort ?
2. How many indicadors should be included for practical use of building sustainability assessment tools ?
3. Should all indicators be mandatory ? If yes, what indicators should be mandatory ?
4. What should be the good practice for benchmarhing the environmental performance of the several types of building (in terms of LCA environmental impact categories) ?
5. Should the sustainability profiles be oriented only for designers or also to building owner, users, etc ?
6. What should be the communication format for users ? Label, profile, description, other ?