Full Cost Assessment: A Method to Analyse Sustainability of Buildings

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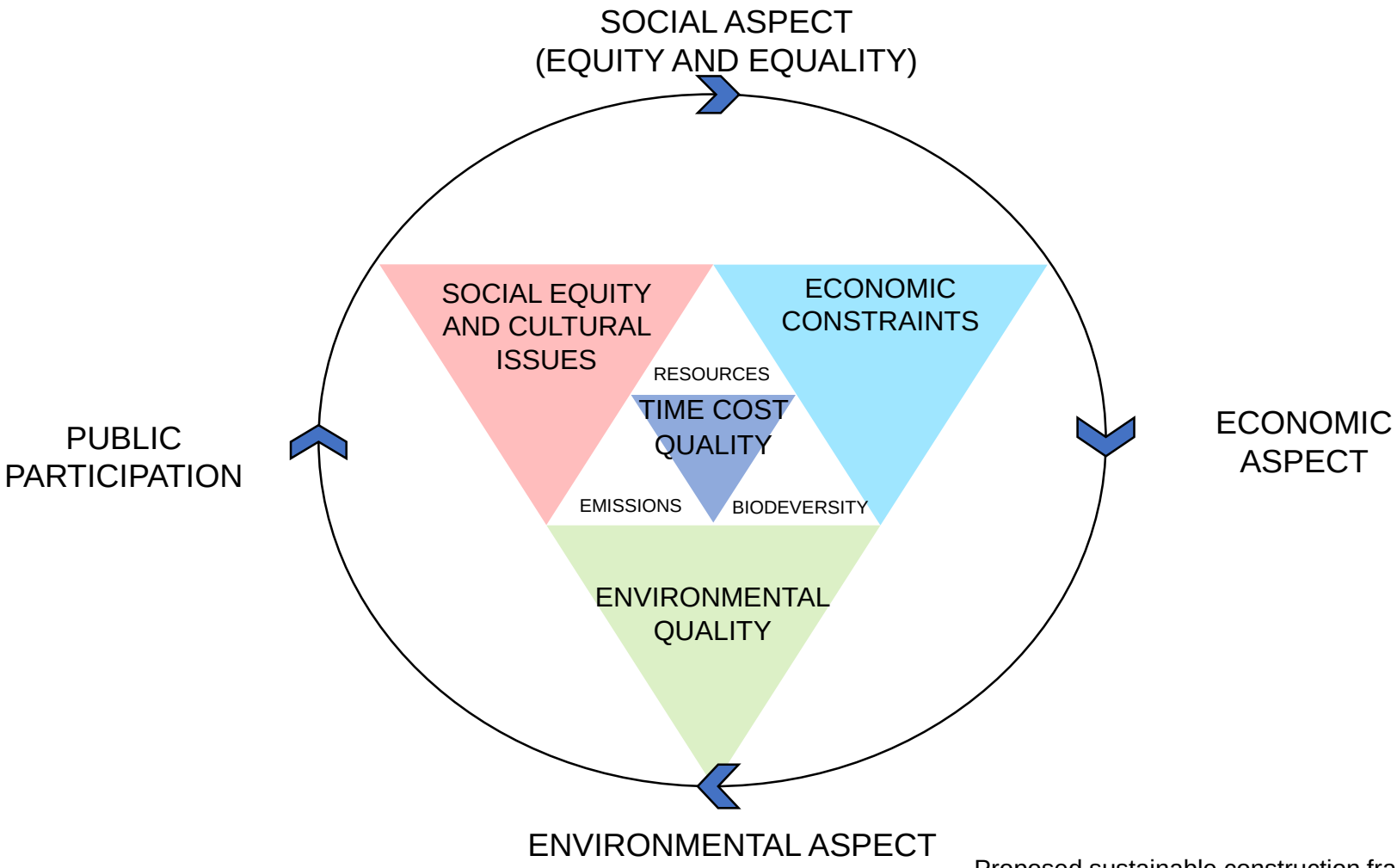
Contents


'...development that meets the needs of the present without compromising the ability of future generations to meet their own needs.' (Brundtland 1987, p.16)
Source: Lubasi - Catedral Verde, Floresta Amazonica

Sustainable Construction

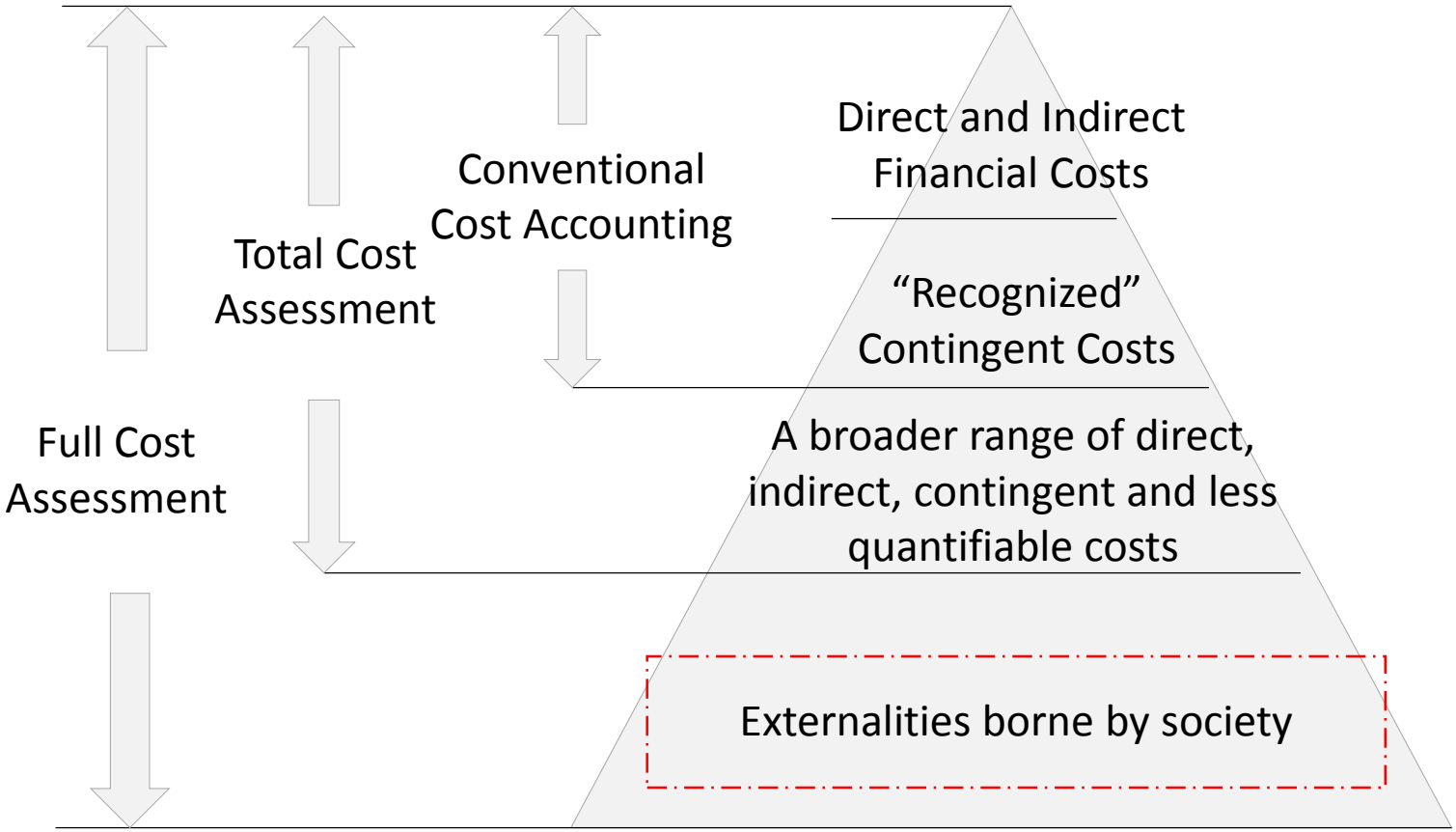


Proposed sustainable construction framework
(Aye & Mirza 2006)

Full Cost Assessment

- Method for identifying and quantifying costs and benefits of environmental, social and economic aspects
- Decision-making support
- Allows to adjust the existing prices of goods and services by monetising and incorporating both positive and negative sides of internal and external aspects (Jasinski et al., 2015, pp. 1124)

Full Cost Assessment



Environmental accounting methods
(MELP 1997)

FCA applications

- Oil and gas,
- Energy supply,
- Waste management,
- Chemical process,
- Transport system,
- Urban development.

Externalities

- Air pollutants
- Greenhouse gas emissions
- Soil depletion
- Water Contamination
- Biodiversity depletion
- Creation of adverse micro climate
- Sub-optimal use of resources

Source: Pixabay

Knowledge Gap

- Few studies have focused on quantifying externalities in buildings (Xing et al. 2007; Liu 2014)
- The consideration of the three spheres of sustainable development has been partially included for quantifying externalities in projects
- Lack of clear and established methodology approach (Xing et al. 2007; Liu 2014)

Aim

- To identify the benefits and limitations of FCA for the evaluation of more sustainable buildings

- Objectives
  - Identification of relevant FCA case studies
  - Methods
  - Applicability to buildings

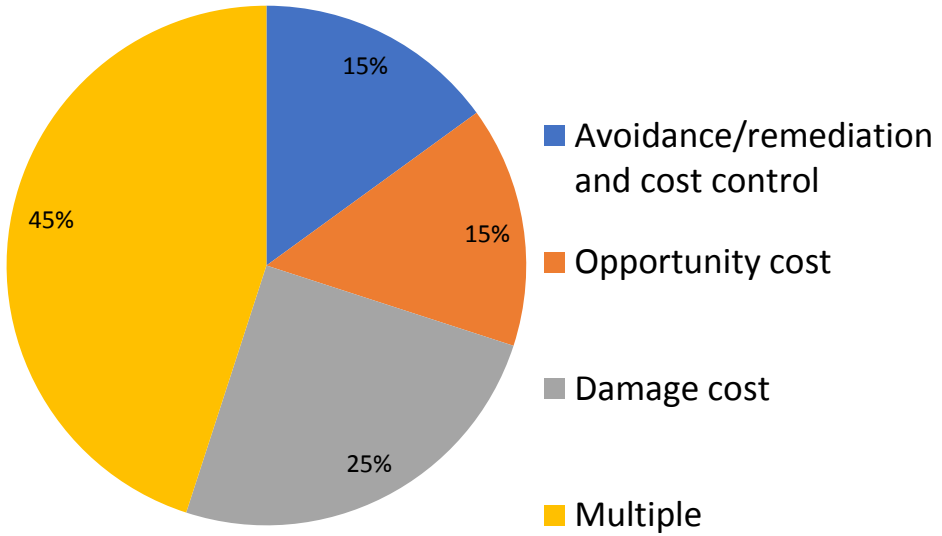
Literature Review

(21 case studies from 1992 to 2015)

- All studies consider economic aspects
- All except one consider environmental aspects
- 12 studies consider social aspects
- 16 studies include internal and external factors
- Analysis vary from 1 year to 30 years period
- 4 types of evaluation methods were identified

FCA Methods

- Avoidance and remediation cost control
  - Forum for the future
- Opportunity Cost
  - Sustainable value concept
- Damage Cost
  - Multi-criteria Analysis
  - Cost-benefit analysis (CBA)
  - ExternE framework
- Multiple approaches
  - Damage function approach + VED
  - LCC + LCA + VS
  - Sustainability index
  - CBA + Wider Economic Benefits (WEBs)



	FCA Approach	EC	E	S	Cost focus	Period	Principal valuation technique	Sector	Reference
A	Forum for the Future	✓	✓	×	Internal and External	1 Year	CBA	Automotive Industry	(Huizing & Dekker 1992)
		✓	✓	×	Internal and External	1 Year	SCC	Forestry industry	(Rubenstein, 1994)
		✓	✓	✓	Internal and External	1 year	Multi-attribute accounting + SCC	Landcare Research	(Bebbington & Gray 2001)
	Ontario Hydro	✓	✓	×	External	1 Year	Market methods	Electric Power Generation	(USEPA 1996)
	Value of Damage	✓	✓	×	Internal and External	-	Contingent valuation	Agriculture	(Whitby & Adger 1996)
B	Sustainable Value (SV)	✓	✓	×	Internal and External	5 Years	CGS	Electric Power Generation	(Atkinson 2000)
		✓	✓	×	Internal and External	1 Year	Opportunity cost	Oil and Gas	(Figge & Hahn 2005)
C	ExternE	✓	✓	×	Internal and External	-	IPA	Energy	(Bickel & Rainer 2005)
	SAM	✓	✓	✓	Internal and External	3 Years	CBA	Waste Management	(Cavanagh et al. 2006)
		✓	✓	✓	Internal and External	-	CBA	Waste Management	(Cavanagh et al. 2007)
		✓	✓	✓	Internal and External	-	CBA	Building	(Xing et al. 2007)
		✓	✓	✓	Internal and External	-	CBA	Urban Development	(Xing et al. 2009)
D	Monetised LCA	✓	✓	✓	Internal and External	20 Years	LCA + ExternE	Thermal Power	(Venema & Barg 2003)
		✓	✓	×	External	-	LCI + LCA + Multiple	Industrial Process	(Antheaume 2004)
		✓	✓	✓	External	-	LCA	Coal industry	(Epstein et al. 2011)
	WAMED (SAM)	✓	✓	✓	Internal and External	2-32 Weeks	CBA + EUROPE + COSTBUSTER	Waste Management	(Mutavchi 2012)
	AQVM	✓	×	✓	External	7 Years	DFA + VED	Oil and Gas	(Kerr 2004)
	Extended LCC	✓	✓	×	Internal and External	20-35 Years	LCC + LCOE	Electric Power Generation	(Roth & Ambs 2004)
	Integrated SAM	✓	✓	✓	Internal and External	30 Years	LCC + LCA + VS	Building	(Liu 2014)
	Sustainability Index	✓	✓	✓	External	-	PCA/FA	Transport	(Reisi et al. 2014)
	Risk appraisal (SAM)	✓	✓	✓	Internal and External	30 Years	CBA + WEB	Infrastructure	(Lai 2015)

[A] Avoidance/remediation and cost control; [B] Opportunity Cost; [C] Damage Cost; [D] Multiple [EC] Economic [E] Environmental [S] Social

Applicability to Buildings

- FCA approach allows monetising costs which may arise from external factors that are usually not taken into account, and, therefore, uncertainties reduced.
- There is a wide range of external indicators which could be used in further FCA applications in the building sector.

Applicability to Buildings

- External impacts on atmosphere, hydrosphere, pedosphere and biosphere,
- Human health and reduction in mortality and morbidity,
- Workforce and productivity,
- Value of time,
- Welfare,
- Innovation and technology,
- Others..

Wider Economic Benefits (WEBs)

Five key WEBs

(Kernohan & Rognlien 2011; Kristensen 2015)

- Business time and reliability savings
- Agglomeration economies
  - Economies of scale and network effects
- Labour supply
  - Qualified workforce and gender balance
- Job reallocation
- Imperfect and/or increased competition

Source: Wikiby

Source: Wikimedia

Source: Sekisui Heim, 2016

Discussions

- Positive and negative impacts of social, economic and environmental externalities need to be identified, analysed and carefully quantified equally.
- Two studies have focused on quantifying externalities in buildings considering its entire lifecycle.
- Lack of consideration in external benefits.
- Specifically, the quantification of social benefits needs to be considered as its impact may influence significantly in the decision making.

Conclusions

- Quantifying sustainability requires a thorough understanding of effects on economy, environment and society in a lifecycle perspective (risks and uncertainties).
- The inclusion of negative and positive (costs and benefits) of external impacts should be considered.
- There is a clear need of adaptations of its concept to buildings.
- Limitations may be found as adjustments in methods may be necessary.
- Use of FCA studies in the urban development and building areas as a reference and guidance to identify potential external aspects.

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Thank you