PROJECT MANAGEMENT
CENTER FOR EXCELLENCE
A.J. CLARK SCHOOL OF ENGINEERING
Civil & Environmental Engineering Department

CIRCULAR CONSTRUCTION: OPPORTUNITIES AND THREATS

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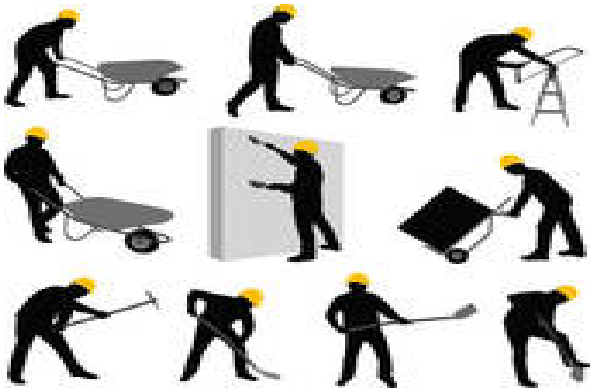
Background

- Construction activities (carpentry, masonry and trenching) generate wastes



- Construction waste causes pollution

Background Continues

- Construction industry contributed 33.5% (871m tonnes) in waste generated by economic activities in EU in 2014 (Eurostat, 2014)
- Construction waste represents one third of total wastes generated annually in the EU
- The C&D sector generates 120m tonnes of waste yearly (UK Green Building Council)

Background Continues

- Construction industry is the largest contributor to waste
  - In the US, 40% of solid waste comes from C&D
  - In Finland, construction industry is responsible for 18% of the 90m tonnes of waste generated annually (Sitra, 2015)
  - In Australia, 53.7m tonnes of waste generated in 2009 & 2010 comes from construction (ABS, 2013)
  - Less than one third of C&D waste is recovered, reused or recycled (WEF, 2016)

Background Continues

- Large portion of C&D waste is landfilled
  - 44% of construction waste in Australia and UK end up in landfill
  - 29% in the US
  - 54% in Finland (Sitra, 2015)
  - 35% globally (DEFRA, 2013)
- Traditional method of construction could be responsible for high waste generation
- Traditional method = Linear economy model

Background Continues

- Linear Economy Model

Take → Make → Use → Dispose

- Traditional construction method:
  - Unsustainable
  - Resource inefficient
  - Wasteful
  - Problematic
  - Large amount of energy
  - Environmental issues
- It's crucial the industry shifts to alternative methods and processes

Background Continues

- Circular Economy (CE) Model

Take → Make → Use → Regenerate

  - Sustainable
  - Regenerative by intention and design
  - "Resource-product-waste-regenerate resource" (Guohui & Yunfeng, 2012)
  - CE Principles: Reduce, Reuse and Recycle
  - Strong links exist between CE principles, environment and economics (Heshmati, 2015)

The Concept of the Circular Economy

- CE is rooted in:
  - Ecological
  - Environmental economics
  - Industrial ecology
- CE originates from:
  - Eco-Industrial Development (EID) theory & thought
  - General systems theory developed by Von Bertalanffy (1950; 1968)

- The term CE was coined by David Pearce and R. Kerry Turner (two British environmental economist) in 1990

- CE is *" an economy system which is characterised by principle of sustainable growth and depends less on depletion of natural resources than traditional economies through mechanism of recycling the waste output of its system"*
(Liu, 2012 p. 256)

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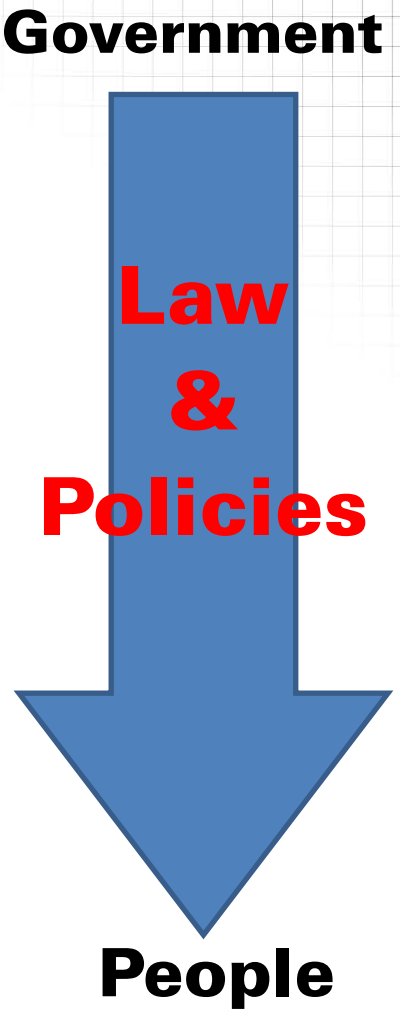
Central theme of CE
Environmental Protection
Waste Prevention
Resource Reuse
Material Recycling

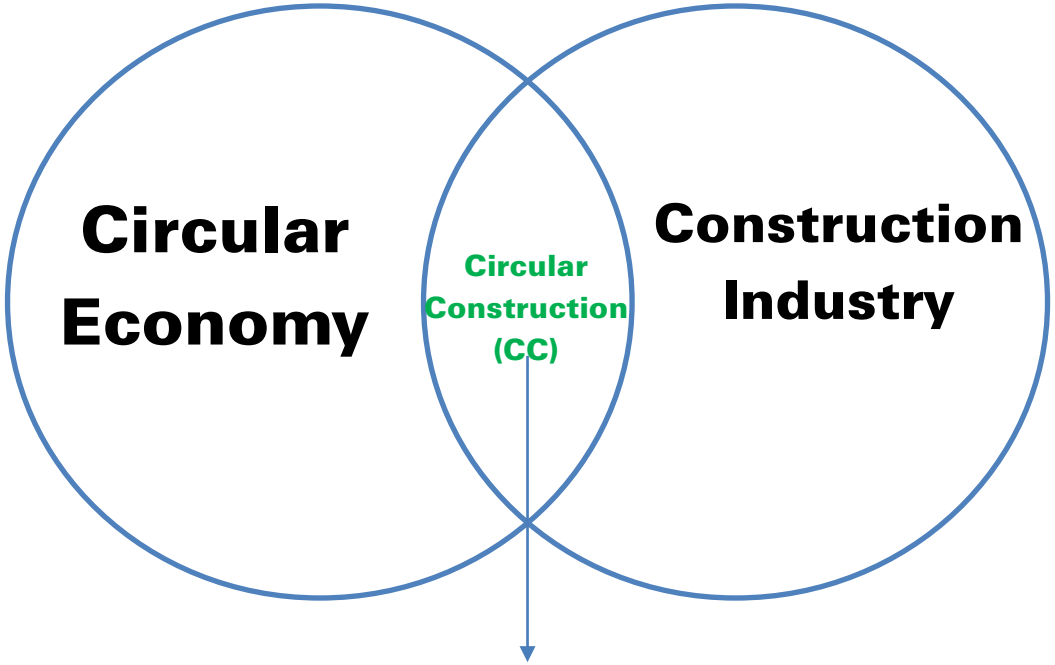
Principles of CE
Re-imagine
Redesign
Reduce
Reuse
Recycle



- Implementation stages and areas of CE in China

Areas	Micro (Enterprise)	Meso (Inter firms)	Macro (Provinces, Region, State and Cities)
Design	Eco-design	Environmentally friendly design	Environmentally friendly design
Production	Cleaner production	Eco-industrial park	• Eco-city • Eco-municipality • Eco-province
Consumption	Green purchase and consumption	Environmentally friendly park	Renting service
Waste management	Product reuse and recycle system	• Waste trade market • Industrial symbiosis	Urban symbiosis

Adapted from Su et al. (2013)



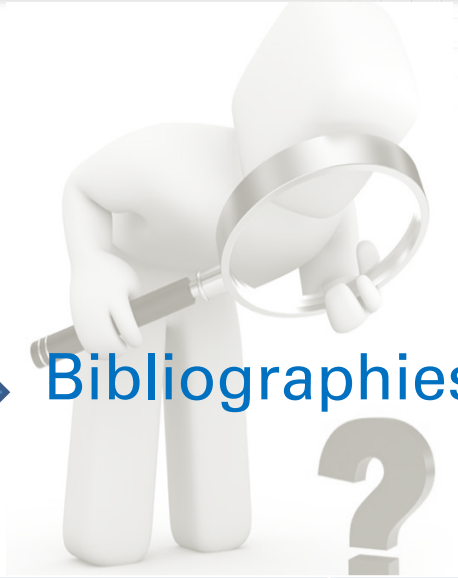
- Circular construction ensures products (i.e. buildings) are regenerative at the end of their lives through recovery, reuse and recycling of their components.

- **Research Questions**
  - What opportunities are available with the adoption of CC?
  - What threats inhibit the adoption of CC?

Methodology

- Systematic Review

Abstract ⟶ Full text ⟶ Bibliographies ⟶ Additional journals



Keywords	Journal type	Time period	Total
• Circular economy • Opportunities • Threats • Sustainable construction • Resource efficiency • Construction wastes	Peer reviewed	2006 - 2017	**75**

Findings

- Opportunities of Circular Construction
  - *Social*
  - *Economic*
  - *Environmental*
  - *Technological*
- Threats to Circular Construction
  - *Professional*
  - *Client*
  - *Industry*
  - *Government*

Findings Continues

Social Opportunities

- Improve collaboration between clients and professionals (Yuan et al., 2006)
- Improve relationship between local societies and industrial sectors (Geng et al., 2012)
- Reduce unethical practices and corruption (Andrews, 2015)
- Facilitate selection of non corrupt suppliers
- Strengthen national security (Su et al., 2013)
- Integrate population, close income gaps and promote social justice (Zhijun and Nailing, 2007)

Findings Continues

Economic Opportunities

- Ensure economic growth without extracting more resources (Ghisellini et al., 2015; Persson, 2015; Jun and Xiang, 2011; Zhu et al., 2010)
- Ensure resource productivity, material cost reduction, and increased revenue from waste sales (Yuan et al., 2006; Moreno et al., 2015; Geng et al., 2012)
- Allay demand-driven price volatility of raw materials and supply risks (Crowther and Gilman, 2014)
- Create new business models (Moreno et al., 2015)
- Create employment opportunities for design graduates and professionals with related expertise (Andrews, 2015)
- Ensure direct cost savings to businesses and serve a market differentiator (Benton, Hazell, and Hill, 2014)

Findings Continues

Environmental Opportunities

- Reform environmental management (Yuan et al., 2006)
- Improve public awareness of environmental issues (Geng et al., 2012)
- Ensure positive environmental outcomes through efficient waste and resource minimisation (Andersen, 2007)
- Mitigate environmental pollution (Wang, 2009)
- Improve eco-efficiency (Yuan et al., 2006)
- Prevent environmental poverty (Zhijun and Nailing, 2007)
- Reduce unsustainable pressure on natural resources, thereby reducing environmental challenges (Preston, 2012; Zhu et al., 2010)
- Conserve natural resources, reduce environmental, avoid use of toxic materials, extend life cycle of landfill sites, and recover local ecosystem (Geng et al., 2012)

Findings Continues

Technological Opportunities

- Increase innovation and adoption of cleaner technologies (Andersen, 2007)
- Assist in industrialisation (Preston, 2012) through industrial symbiosis. (Kalundborg in Denmark is a good example of industrial symbiosis in practice (Damen, 2012))

Clients Threats

- Lack of enthusiasm, life style and fashion (Preston, 2012)
- Lack of awareness, knowledge and understanding of environmental protection and benefits (Xue et al., 2010; Guohui and Yunfeng, 2012; Rizos et al., 2015; Su et al., 2013; Li and Li, 2011, European Commission, 2014)

Findings Continues

Professionals Threats

- Lack of awareness, knowledge and understanding (Meqdadi, Johnsen, and Joh, 2012; Wooi and Zailani, 2010; Xue et al., 2010; Rizos et al., 2015; Li and Li, 2011)
- Inability to adopt new technologies, systems and methods of designing
- Lack of motivation to reuse or recycle materials (Löfgren and Enocson, 2014; EC, 2014)

Findings Continues

Industry Threats

- Poor leadership and management (Su et al., 2013)
- Lack of reliable information systems and shortage of advanced technologies
  (Su et al., 2013; EC, 2014; Liu et al., 2009; Xue et al., 2010)
- Changes in industrial practices and patterns as well as lack of independent organisations to certify CC
  (Preston, 2012)
- Innovation challenge, lack of appropriate quantitative tools for design, and lack of standardization for performance and structures
  (Su et al., 2013; Preston, 2012; Greyson, 2007; Zhu, 2000)

Findings Continues

Government Threats

- Lack of policy coherence (Xue et al., 2010)
- Lack of legal system on CC (Geng et al., 2012)
- Difficulties in enforcing environmental laws
- Lack of financial support
- Lack of enforcement of legislation
  (Su et al., 2013; Xue et al., 2010; Liu et al., 2009)
- Lack of support and encouragement
  (Calogirou et al., 2010; Struder et al.,2010)
- Weak economic incentives (Su et al., 2013; EC, 2014)
- High cost of green investment for firms
  (Preston, 2012; Andrews, 2015; Rizos et al., 2015)

Conclusion

- Resource efficiency, low energy use and waste minimization could be achieved with the adoption of CC
- Adoption of CC could be difficult due to fragmented nature of the industry but it's achievable
- CC provides significant benefits especially at Design (e.g. design for disassembly) and Deconstruction stages (e.g. pre-demolition audits)
- A framework involving all stakeholders would be required for the adoption of CC

Thank you

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