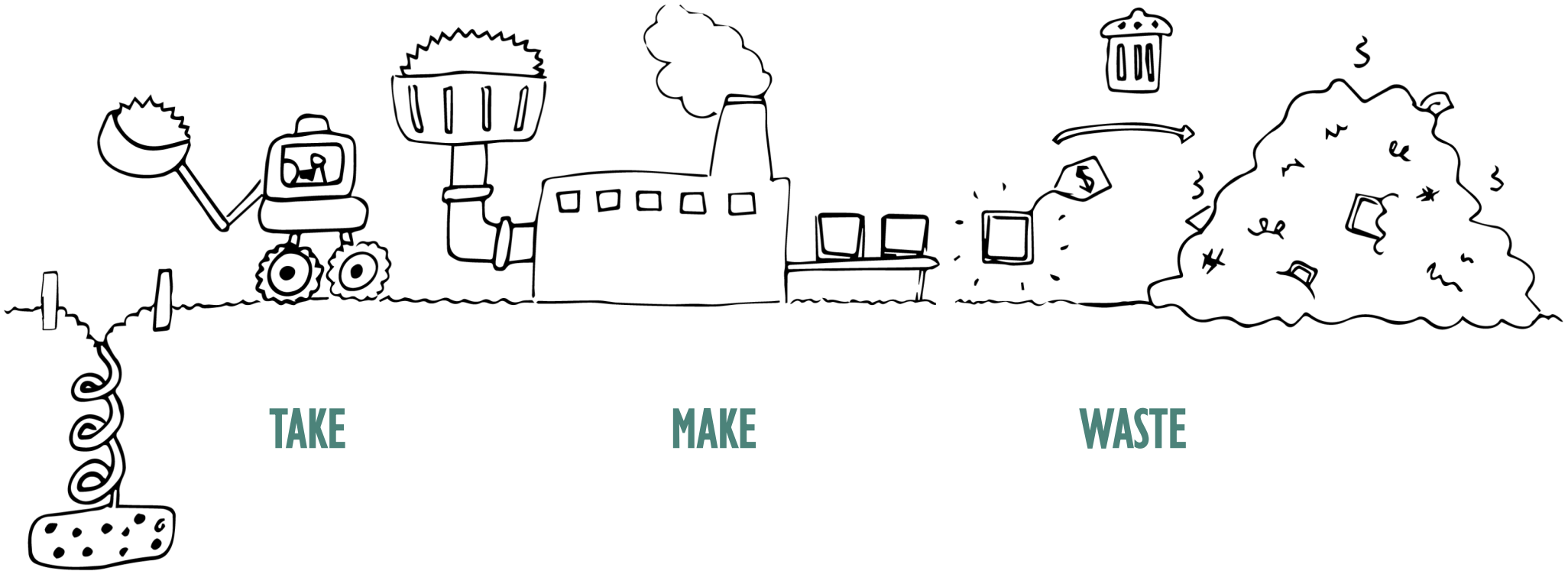
What if?

Source: Unsplash, 2020

TO THIS!

TODAY'S TAKE-MAKE-WASTE ECONOMY



FROM LINEAR TO CIRCULAR ECONOMY

refuse

reduce

repair

reuse

refurbish

re-manufacture

repurpose

recycle

Source: Aurp, 2018

↑ 0.8%-7% GDP growth

↑ 0.2%-3.0% jobs

↓ 8-70% carbon emissions

Source: Ellen McArthur & SUN, 2015

“The number of buildings delivered in a traditional way is disproportionate to the circular buildings.”

- Municipality (personal communication, 2021)

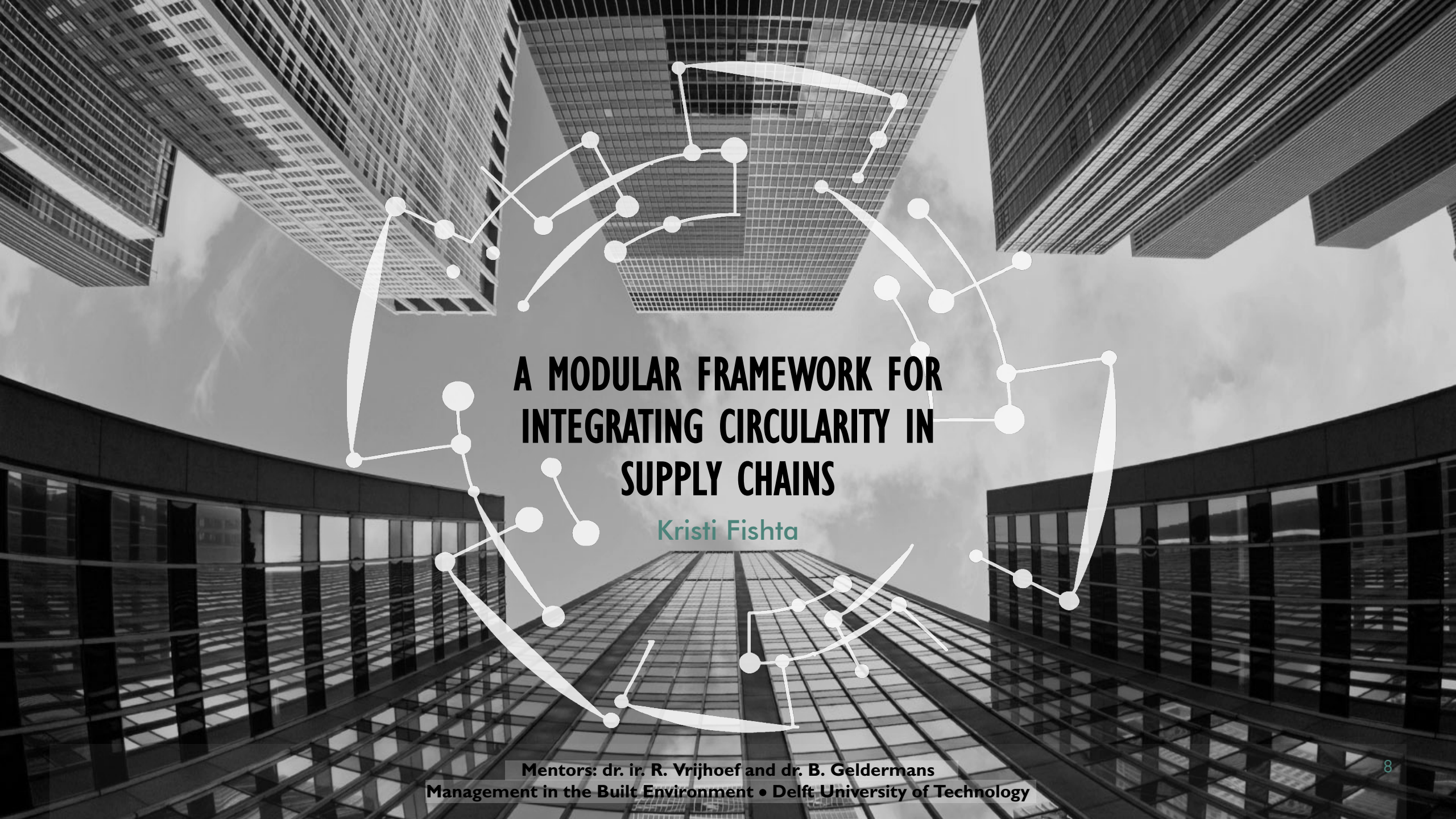
WHY?

LACK OF A SHARED UNDERSTANDING

UNCLEAR BUSINESS MODELS

TEMPORARY COLLABORATION

ONE-OF-A-KIND PROJECT



A MODULAR FRAMEWORK FOR INTEGRATING CIRCULARITY IN SUPPLY CHAINS

Kristi Fishta

Mentors: dr. ir. R. Vrijhoef and dr. B. Geldermans
Management in the Built Environment • Delft University of Technology

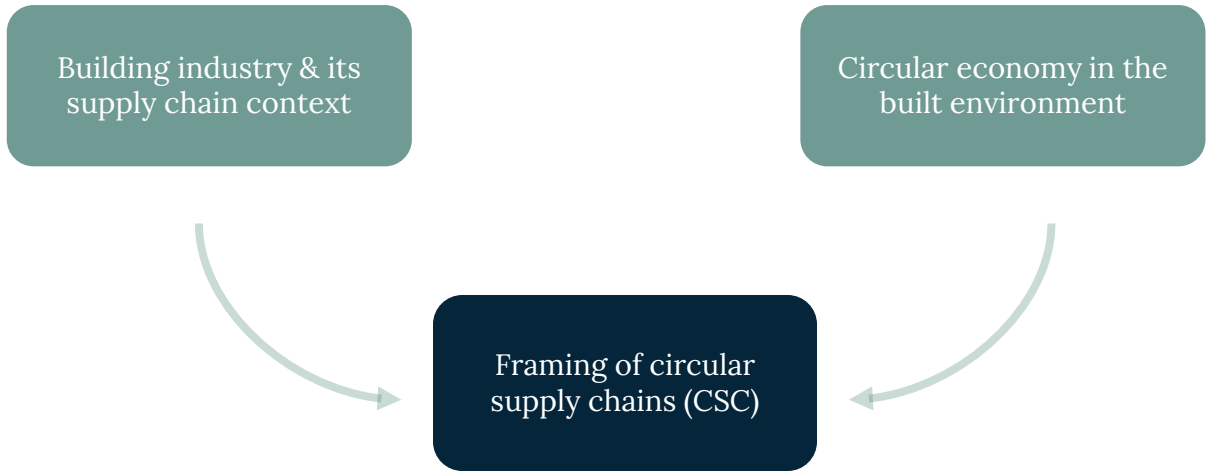
Providing a representation of an entire circular building supply chain

01 THEORETICAL BASIS

A short recap of the current theory

THEORETICAL BASIS

Theoretical Background



"Circular supply chain mean the provision of ***self-sustaining*** production systems, where materials are ***returned*** to such systems, thus ***extending*** the service-life of materials and the ***reduction*** of waste generation."

- (*Genovese et al.*, 2017)

THEORETICAL BASIS

Analytical Framework

Production environment

Organisation environment

Control environment

Social environment

THEORETICAL BASIS

Analytical Framework

Operation & process coordination

Circular reverse loops

Strategy integration

Production environment

Organisation environment

Control environment

Social environment

THEORETICAL BASIS

Analytical Framework

Operation & process coordination

Circular reverse loops

Strategy integration

Internal alignment

Cross-chain collaboration

Information exchange

Production environment

Organisation environment

Control environment

Social environment

THEORETICAL BASIS

Analytical Framework

Production environment	Organisation environment	Control environment	Social environment
Operation & process coordination	Internal alignment	ICT architecture & functionalities	
Circular reverse loops	Cross-chain collaboration	Control facilitator	
Strategy integration	Information exchange	Circular building tools	

THEORETICAL BASIS

Analytical Framework

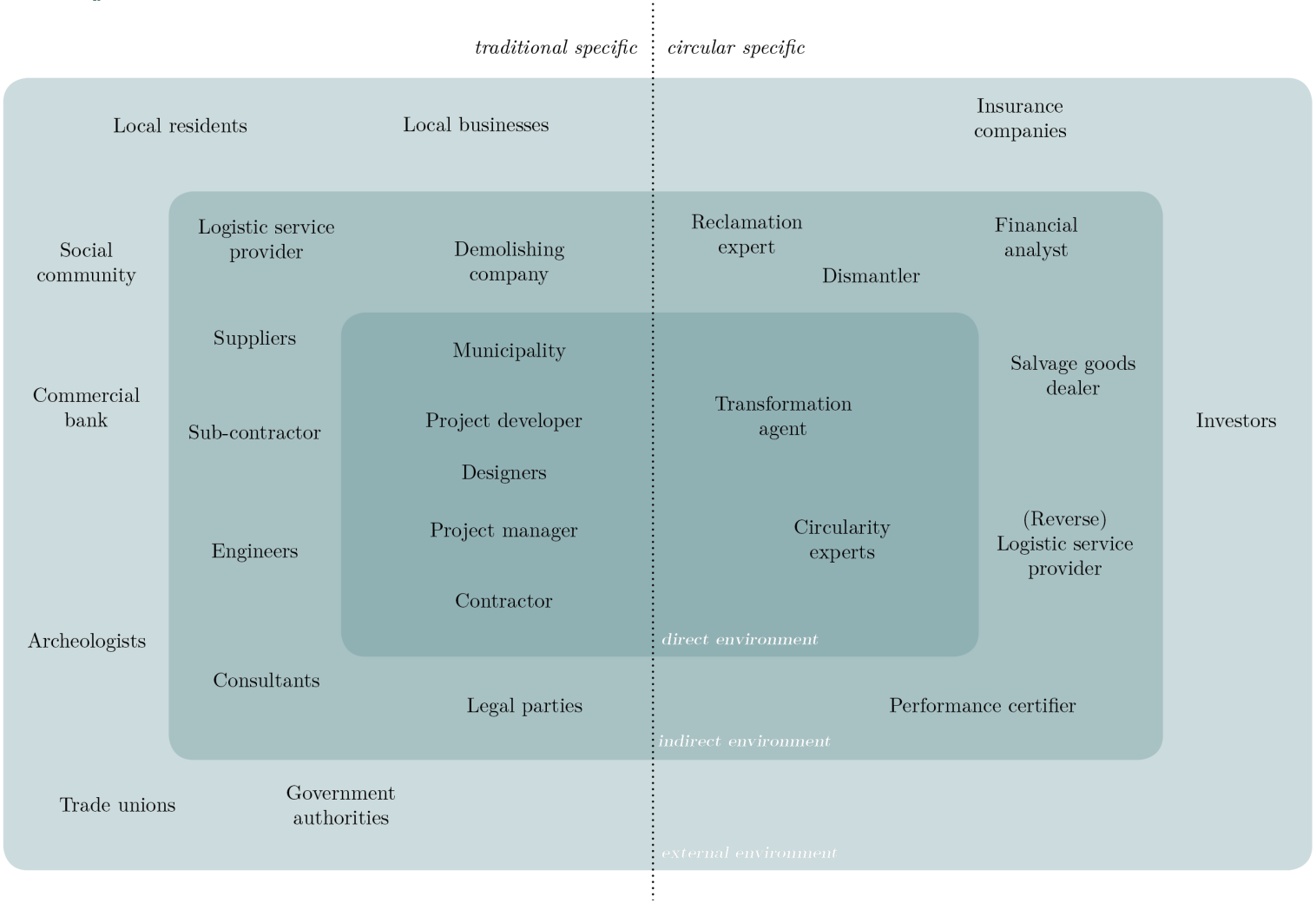
Production environment	Organisation environment	Control environment	Social environment
Operation & process coordination	Internal alignment	ICT architecture & functionalities	Legal (regulatory) factors
Circular reverse loops	Cross-chain collaboration	Control facilitator	Financial factors
Strategy integration	Information exchange	Circular building tools	Cultural factors

02 EMPIRICAL ANALYSIS

Collecting, analysing & synthesising data

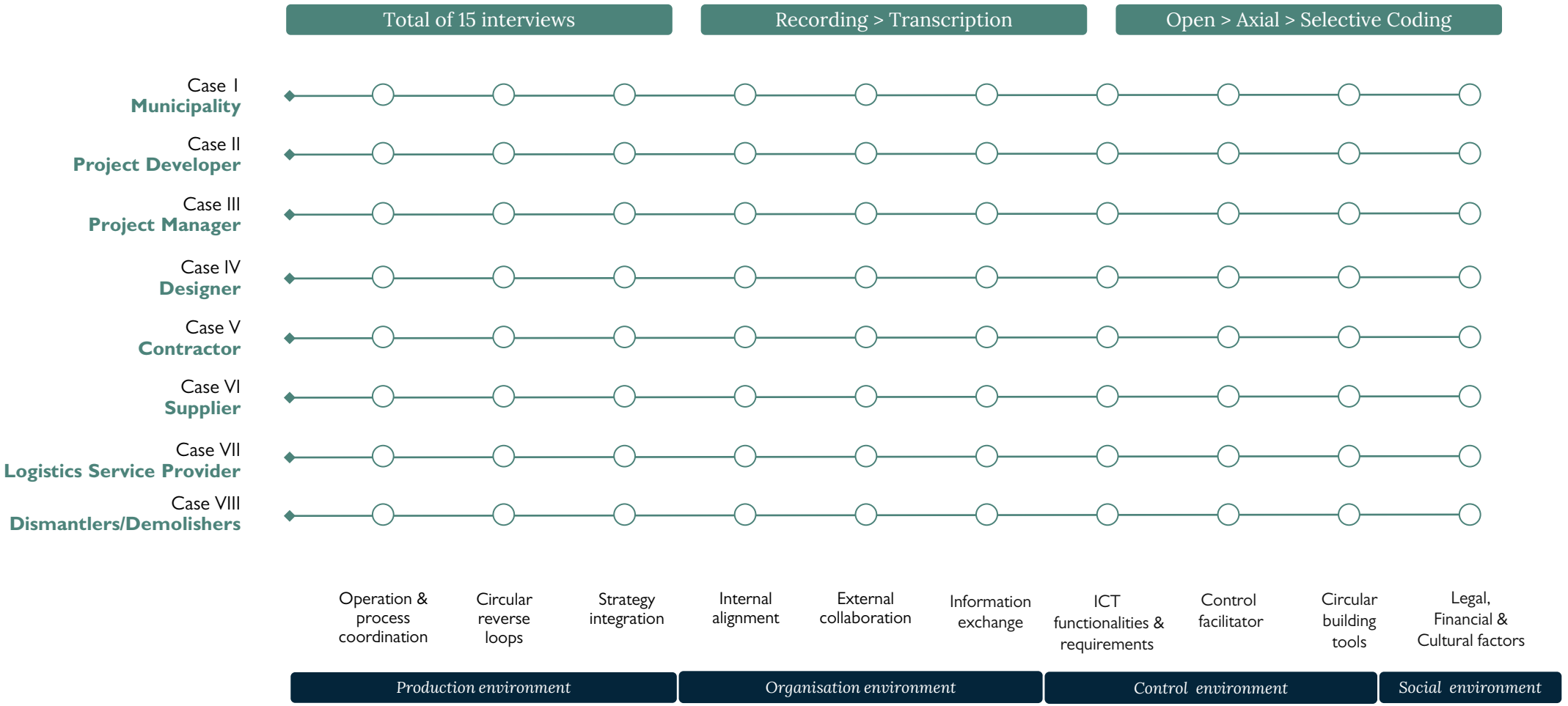
EMPIRICAL ANALYSIS

Primary data | Building industry cases



EMPIRICAL ANALYSIS

Primary data | Building industry cases



EMPIRICAL ANALYSIS

Primary data | Building industry cases

- *Understanding of circular supply chains and its strategy implementation **differed per organisation type** and their **position** in the chain.*
- *Focus on **internally** coordinating operations and processes towards a circular approach.*
- *Reverse loops are enabled since the **initiation** and **design** phases and through building owners.*
- ***Material passports** support appropriate returns of collected materials.*

EMPIRICAL ANALYSIS

Primary data | Building industry cases

- *Internal alignment towards circular building helps understand circular business models.*
- *Traditional stakeholders can/are adapting their business activities, in a way that include circular-specific stakeholder roles.*
- *Cross-chain collaboration mainly happens with a specific set of partners that the company has already established.*
- *Willingness to share information depends due to the stakeholder position and due to maintaining competitive advantage.*

EMPIRICAL ANALYSIS

Primary data | Building industry cases

- *The relatively weak regulatory environment hindrances the creation of entire circular supply chain.*
- *Circular building is more expensive and requires new different financial mechanisms, compared to the traditional process.*
- *Cultural mindset is highly traditional, because there is a lack of urgency to change their way of working and producing.*

EMPIRICAL ANALYSIS

Primary data | Building industry cases

Production environment

Organisation environment

Control environment

Social environment

. . . .

EMPIRICAL ANALYSIS

Secondary data | Circular building tools in building industry

- Identifying of 32 circular building tool
  (based on online researching and academic papers)
- Analysing all 32 circular building tools
- Categorising based on their purpose
  - *Circular business models*
  - *Circular design strategies*
  - *Circularity scores*
  - *Circular procurement & Tendering*
  - *Environmental Impact*
  - *Extending Service-Life*
  - *Practical platforms*
  - *Product/Material Assessment & Choice*

Table 4-3: Categorising tools that support circular economy based on their purpose

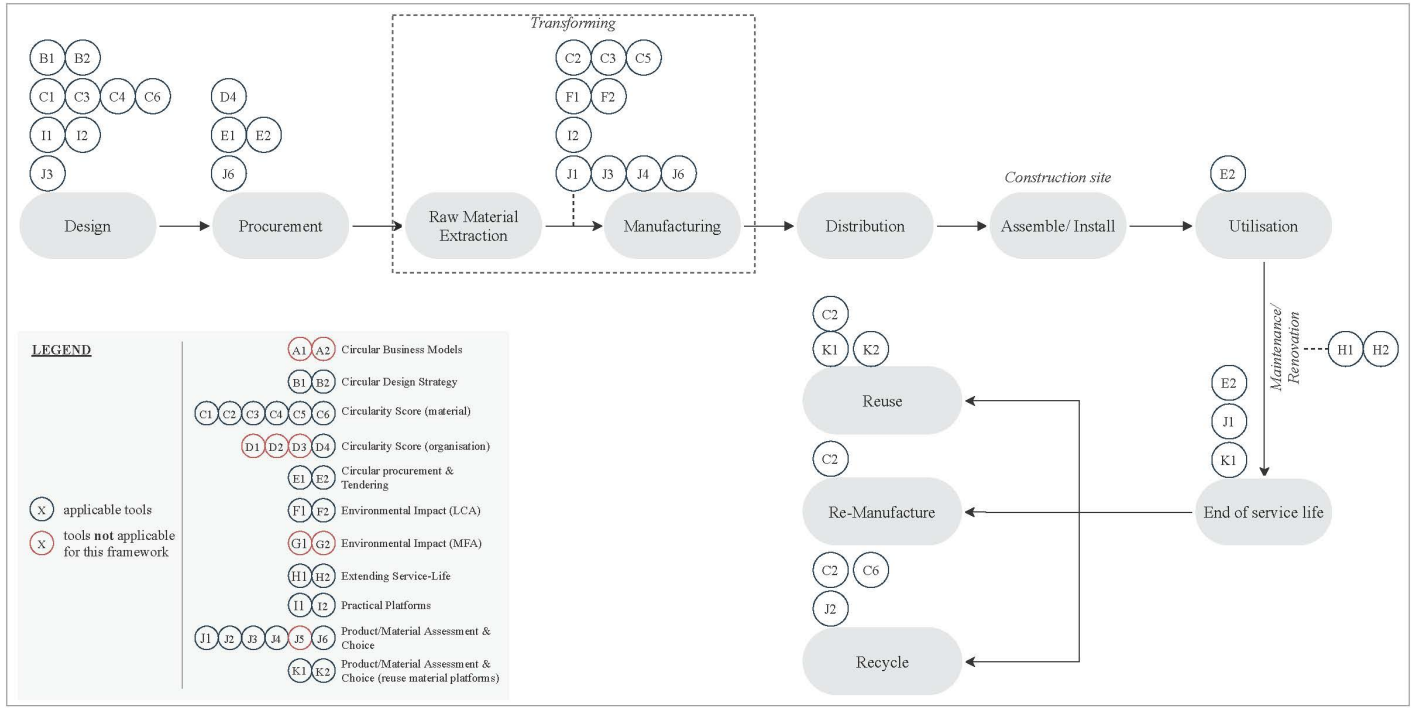
Category	Sub-category	Tools	Code
Circular Business Models	single tool	Circulator	(A1)
	single tool	ECR	(A2)
Circular Design Strategy	single tool	Circular Design Guide	(B1)
	single tool	CLD	(B2)
Circularity Score	Material Scores	CBA	(C1)
		Circularity Calculator	(C2)
		Circularity Check	(C3)
		GPR Gebouw	(C4)
		PLCM	(C5)
		Recycling Index	(C6)
	Organisational Scores	Circle Assessment	(D1)
		CTI	(D2)
		Circulytics	(D3)
		Optimal SCANS	(D4)
Circular Procurement & Tendering	single tool	Life Cycle Vision	(E1)
	single tool	PRP	(E2)
	single tool	Optimal Scans	(D4)
Envionmental Impact	LCA	ECR	(A2)
		IMPACT	(F1)
		ReCipe method	(F2)
	MFA	MCI	(G1)
		VRE	(G2)
Extending Service-Life	single tool	Dutch Property Inspections	(H1)
	single tool	O-Prognose	(H2)
Practical Platforms	single tool	MarketplaceHUB	(I1)
	single tool	Platform CB'23	(I2)
Product/Material Assessment & Choice	single tool	BCI	(J1)
	single tool	CEI	(J2)
	single tool	Madaster Circularity Indicator	(J3)
	single tool	MRS	(J4)
	single tool	Milieuclassificaties Bouwproducten	(J5)
	single tool	ReNtry	(J6)
	Reused Material Platforms	Gebruikte Bouwmaterialen Marktplaats	(K1)
		Insert Marktplaats	(K2)

EMPIRICAL ANALYSIS

Secondary data | Circular building tools in building industry

- Synthesising the analysis: identifying their location of influence in the chain

  - *Oversupply of tools with similar purposes*
  - *Lack of connectivity*
  - *Lack of focal integrating tools*
  - *Lack of shared common language*
  - *Rises the "greenwashing" issue*



03 THE MCSCM

An introduction to the proposed model

MCSCM OPERATIONALISATION

SUPPLY CHAIN MODELLING

represents one of the cognitive activities of a topic, which includes the development of a model to be used to conduct investigations, and provision of results or recommendations on its quality to the problem at hand.

GRAPH BASED MODEL

enables the representation of complex models into respective modules, while providing flexibility for the modelling environment.

PROCESS LEVEL

represents the activities that occur within an organisation which can be static or dynamic

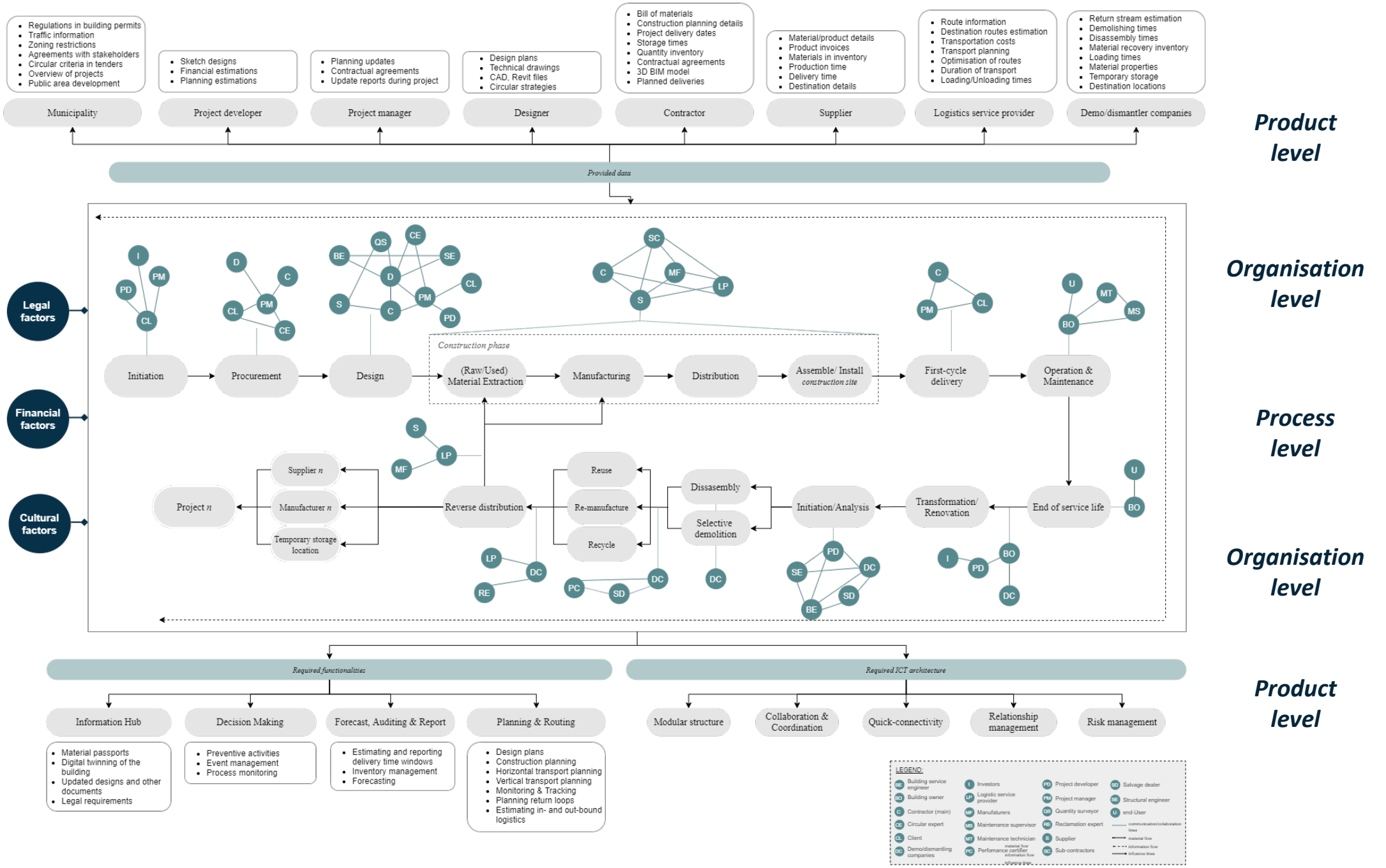
ORGANISATION LEVEL

represents the relations that lay between stakeholders

PRODUCT LEVEL

represents the control environment that supports the process and organisation interactions

THE MCSC MODEL



Product level

Organisation level

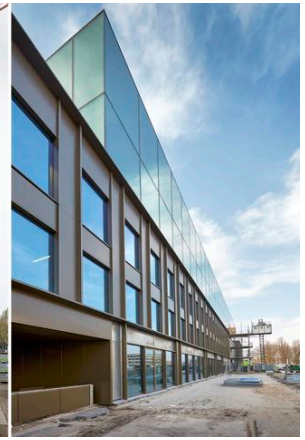
Process level

Organisation level

Product level

BRINGING MCSC MODEL CLOSER TO REAL-WORLD IMPLEMENTATION

EDGE OLYMPIC CASE



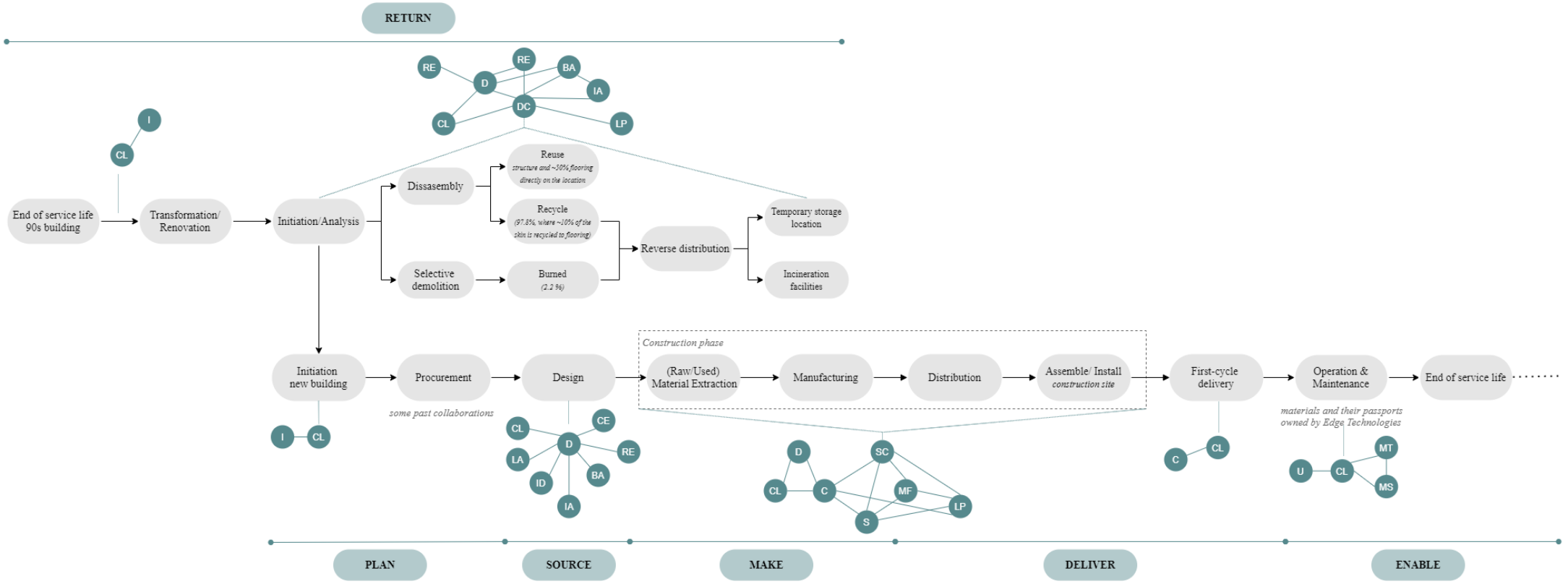
PROJECT DETAILS

Location: Amsterdam
Project time: 2016-2018
Program: Office building

Stakeholders:
Client-Developer: Edge Technologies
Building management: Edge Technologies
Architect: de Architekten Cie.
Contractor: J.P. van Eesteren
Dismantler: Beelen B.V.
Interior architect: de Architekten Cie. & Amsterdam gemeente
Landscape architect: Fokkema Partners & Concrete Architects
Circularity expert: BREEAM
Reclamation expert: Superuse Studios
Building advisor: DGMR

BRINGING MCSC MODEL CLOSER TO REAL-WORLD IMPLEMENTATION

EDGE OLYMPIC CASE



LIMITATIONS & FUTURE RESEARCH

LIMITATIONS & FUTURE RESEARCH

Research limitations

- **Theoretical limitations**
  - Four environments were identified with just a couple variables each.

Future research

Further research is needed to verify (other) variables, and research deeper per variable identified.

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- **Methodological limitations**
  - Sampling of building cases
  - Use of other techniques

Future research

Further research is needed to verify (other) variables, and research deeper per variable identified.

Further research is required per organisation type and establish a deeper understanding per case.

LIMITATIONS & FUTURE RESEARCH

Research limitations

- **Theoretical limitations**
  - Four environments were identified with just a couple variables each.

- **Methodological limitations**
  - Sampling of building cases
  - Use of other techniques

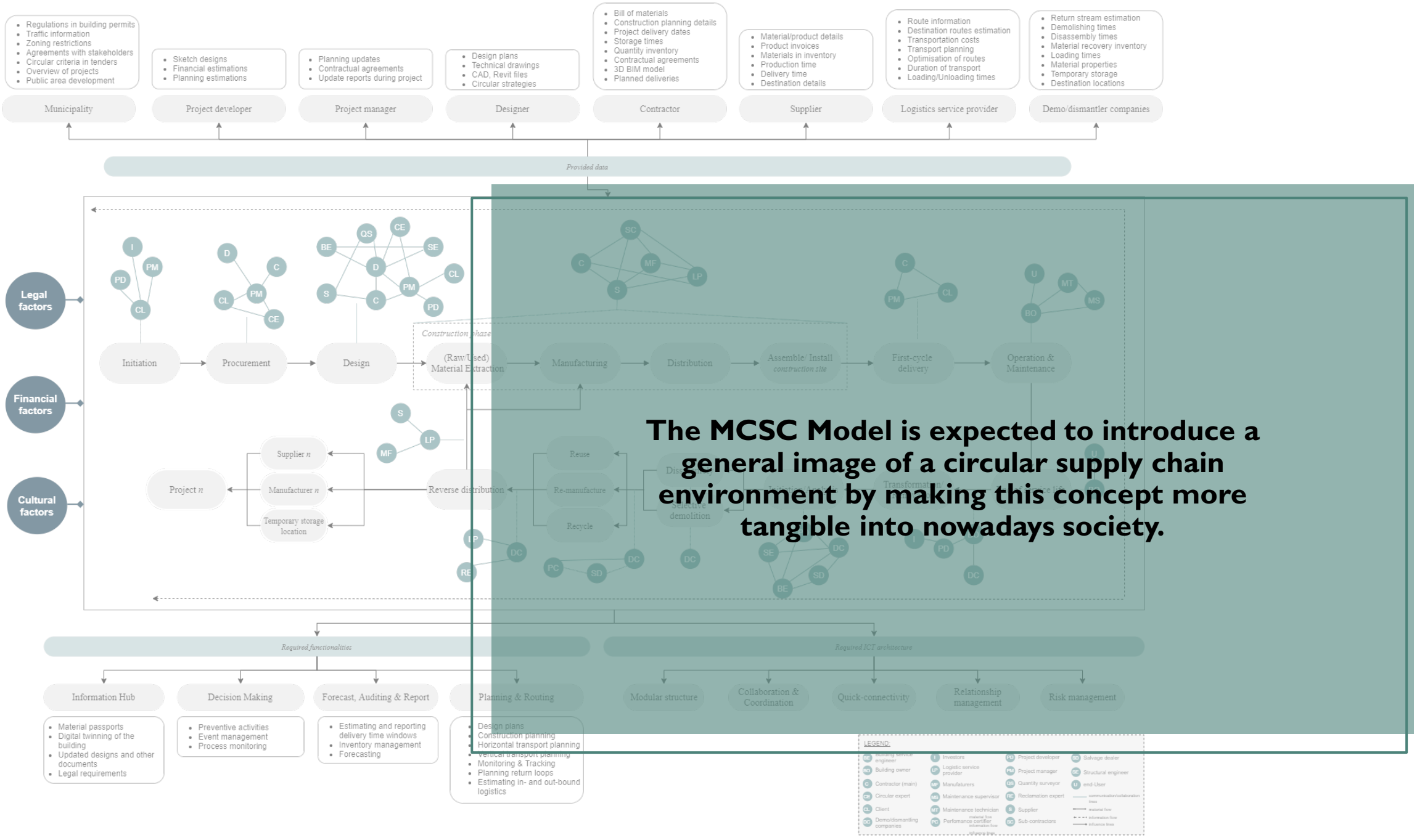
- **Application limitations**
  - One test case representing office project

Future research

Further research is needed to verify (other) variables, and research deeper per variable identified.

Further research is required per organisation type and establish a deeper understanding per case.

Further research is needed to test and validate the modularity towards adapting to **different project types**, such as commercial, residential or other building sectors.



The MCSC Model is expected to introduce a general image of a circular supply chain environment by making this concept more tangible into nowadays society.

“If it can’t be reduced, reused, repaired, rebuilt, refurbished, resold, recycled or composted, then it should be restricted, redesigned or removed from production.”

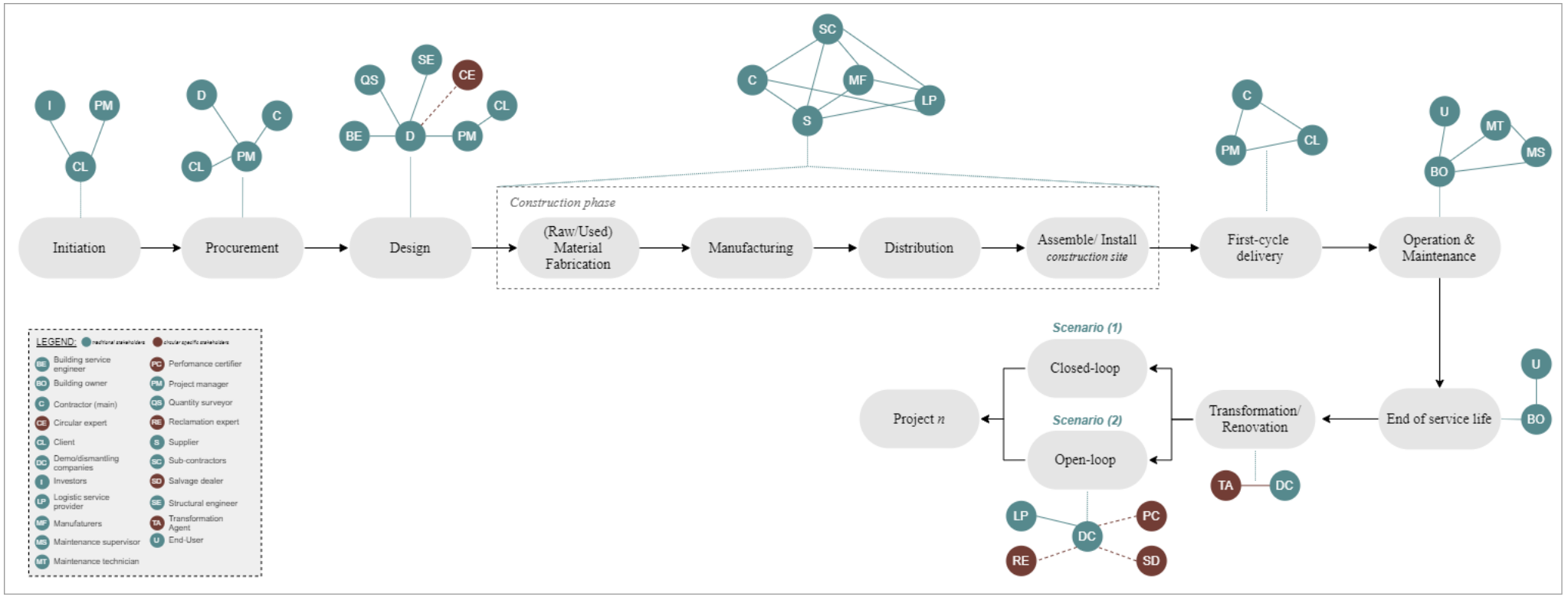
— Pete Seeger


Thank you!
Questions?

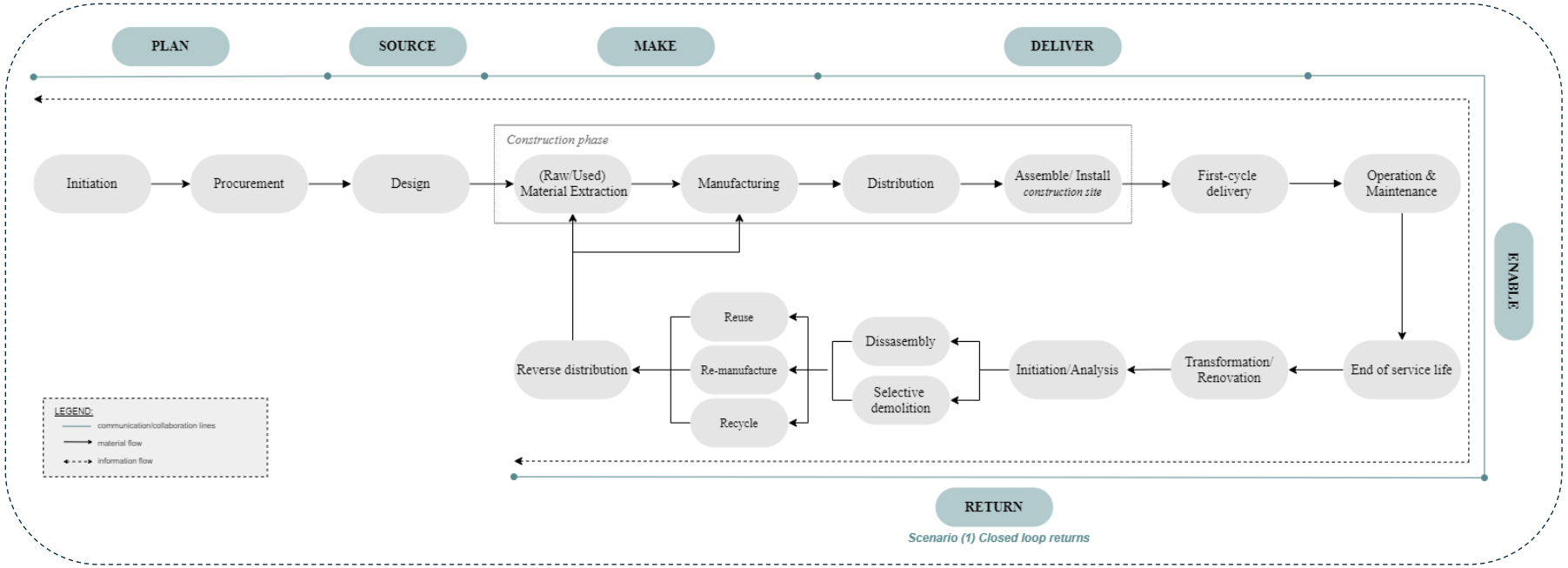
EXTRA SLIDES

THE MCSC MODEL

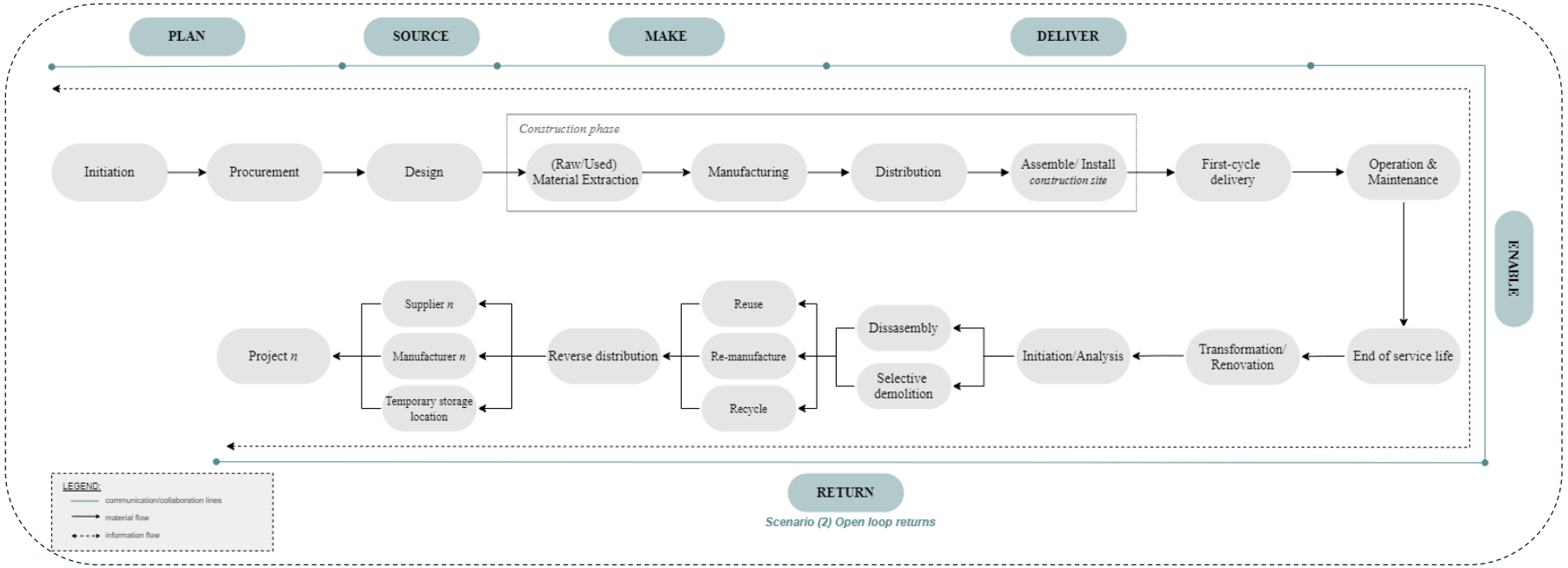
theoretical



THE MCSC MODEL
process



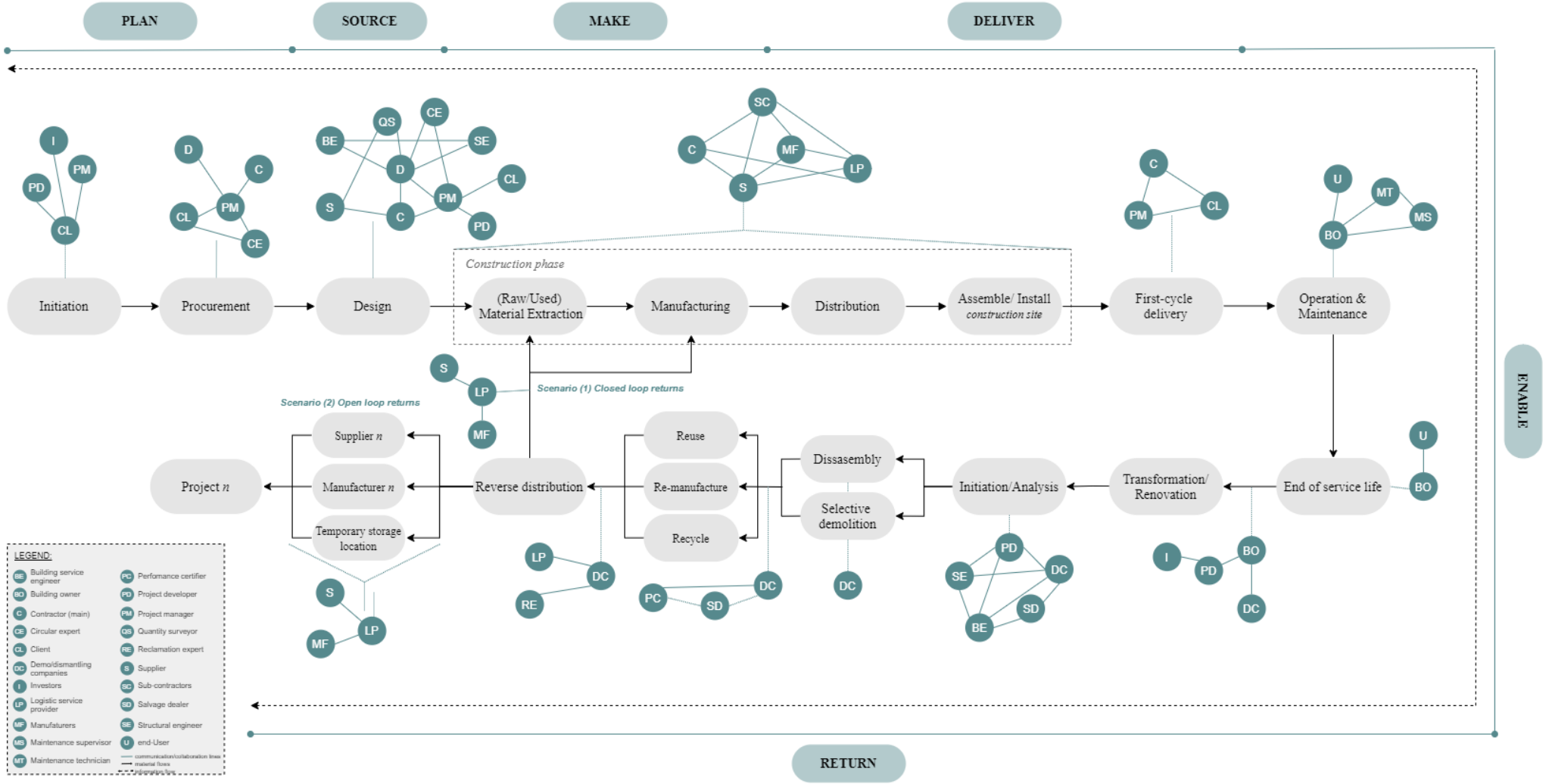
Scenario (1) Closed loop returns



Scenario (2) Open loop returns

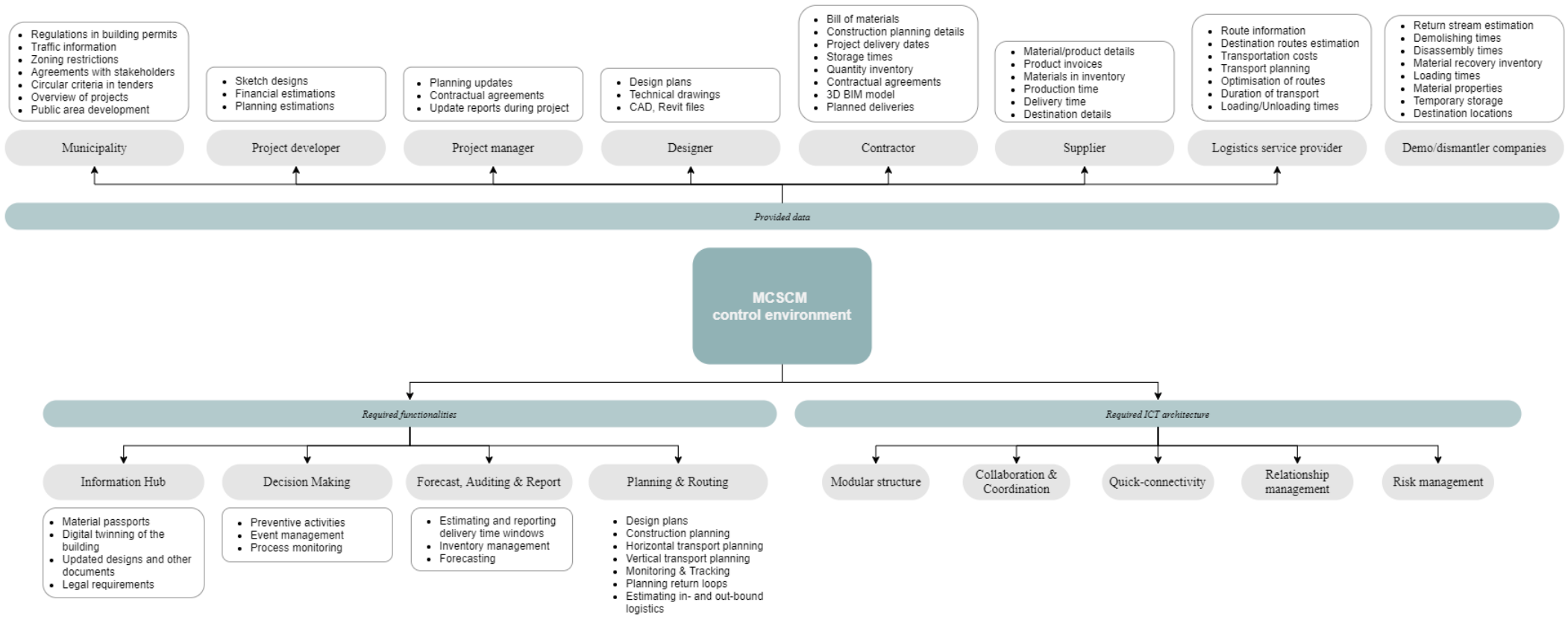
THE MCSC MODEL

organisation



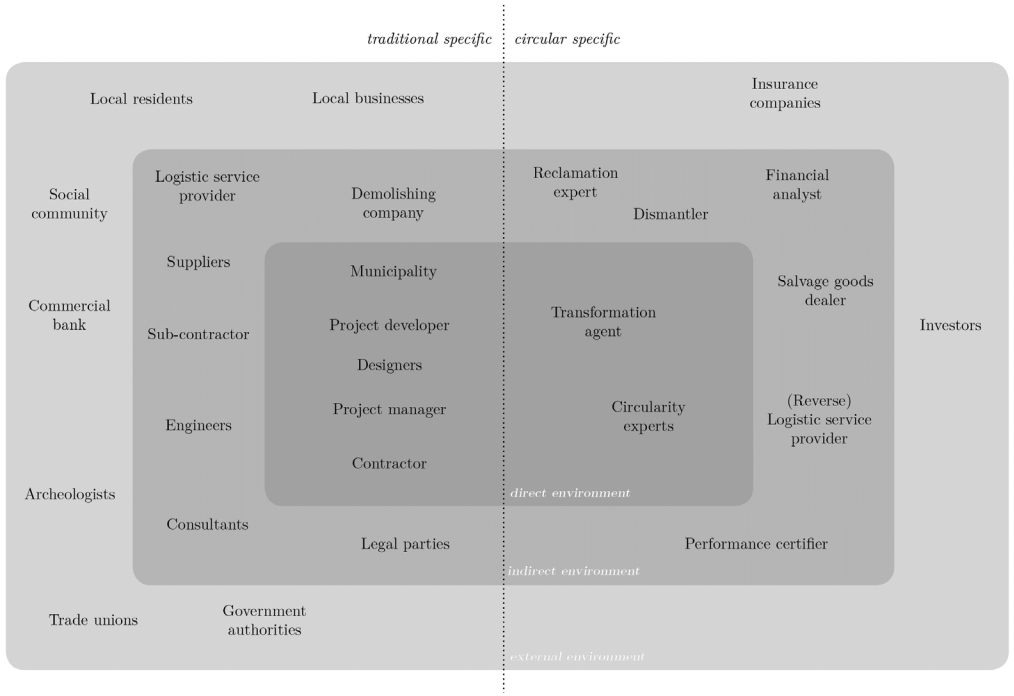
THE MCSC MODEL

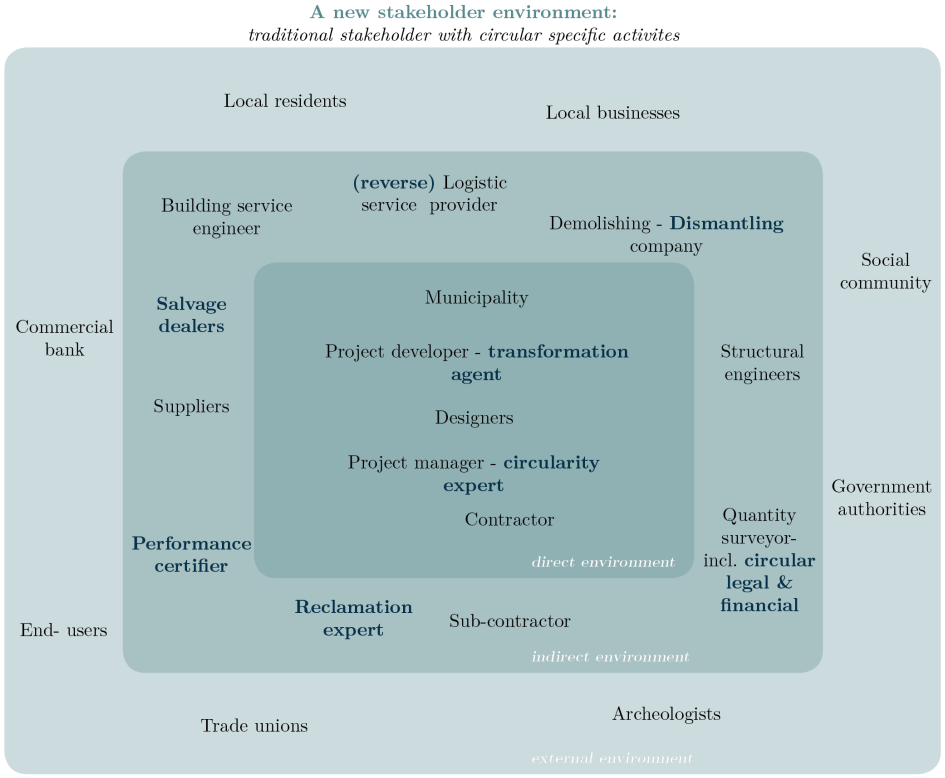
product



THE MCSC MODEL

Organisation level in focus

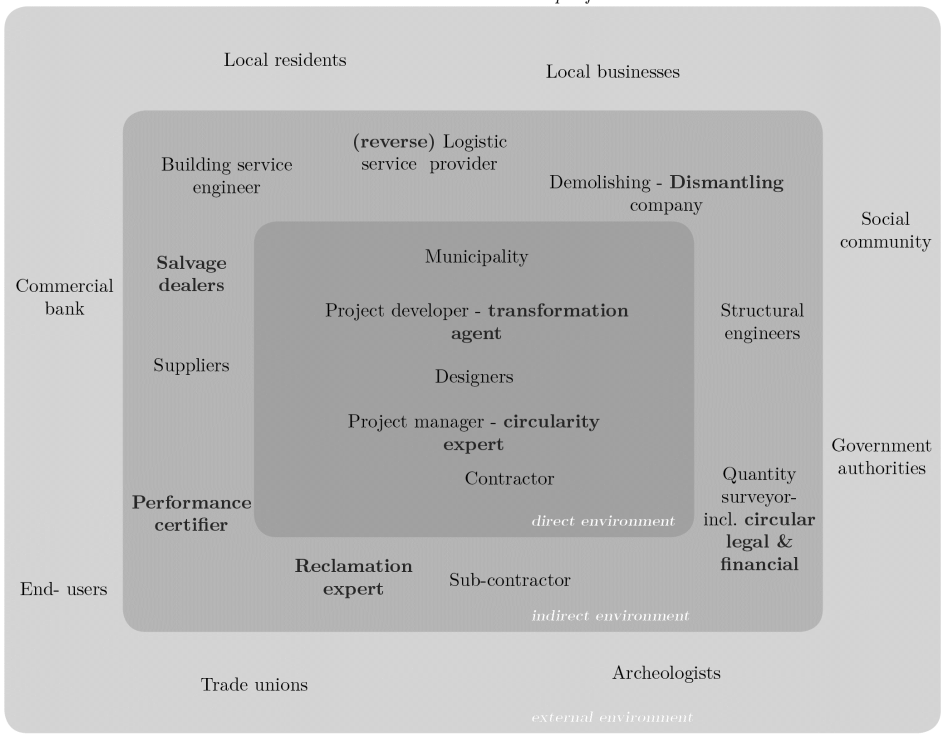




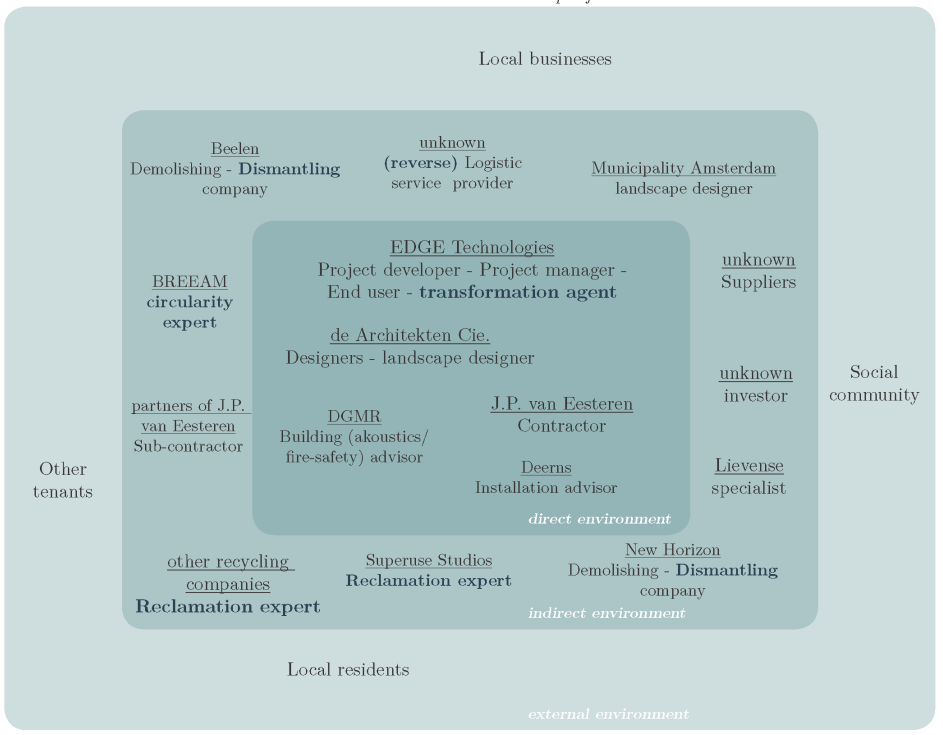
THE MCSC MODEL — EDGE OLYMPIC

Organisation level

A new stakeholder environment:
traditional stakeholder with circular specific activites



Edge Olympic stakeholder environment:
traditional stakeholders with circular specific activites



RESEARCH QUESTION(s)

"How would a circular supply chain environment within the building industry look like based on theoretical and practice inputs?"

Theoretical sub-questions

- What is the nature of the current building supply chains and their management incurrent theory?
- How is the concept of circular supply chains constituted in current theory?
- What are the main variables that allow the design of circular supply chains environment according to theory?

Empirical sub-questions

- What tools and information systems are present within the building industry, facilitating a circular control environment?
- How is the MCSC theoretical model perceived by organisations active in the building industry?

Design sub-question

Proposing a design for a circular building supply chain model.

METHODOLOGY

RESEARCH TYPE

Qualitative empirical research

ANALYSIS UNIT

Building supply chains and the focal companies within them

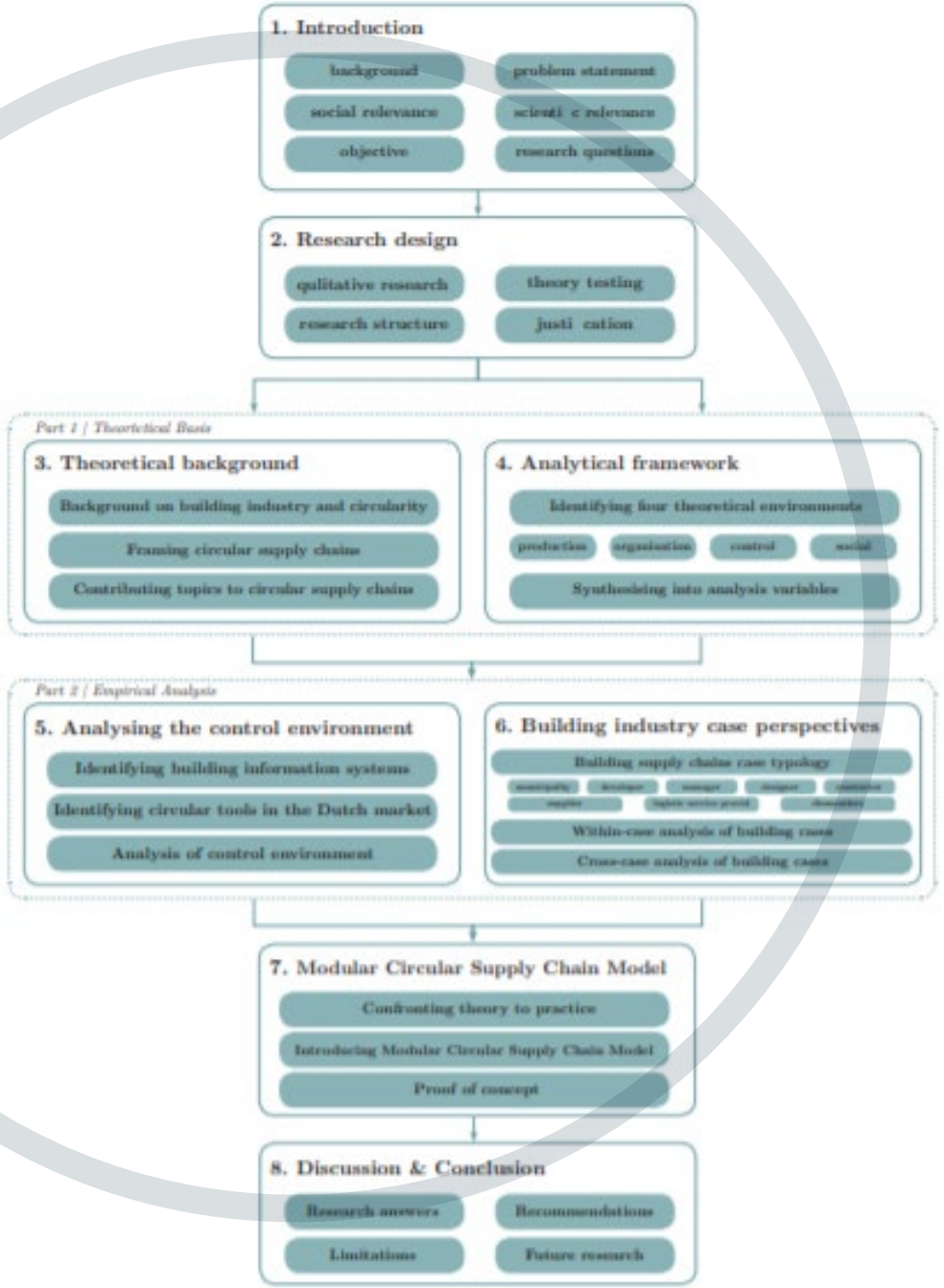
DATA COLLECTION

Primary data: interviews with focal companies

Secondary data: desk study of the current control environment

DATA ANALYSIS

Within- & Cross-case analysis



METHODOLOGY

PART I

Literature background contributing to theoretical framework

PART II

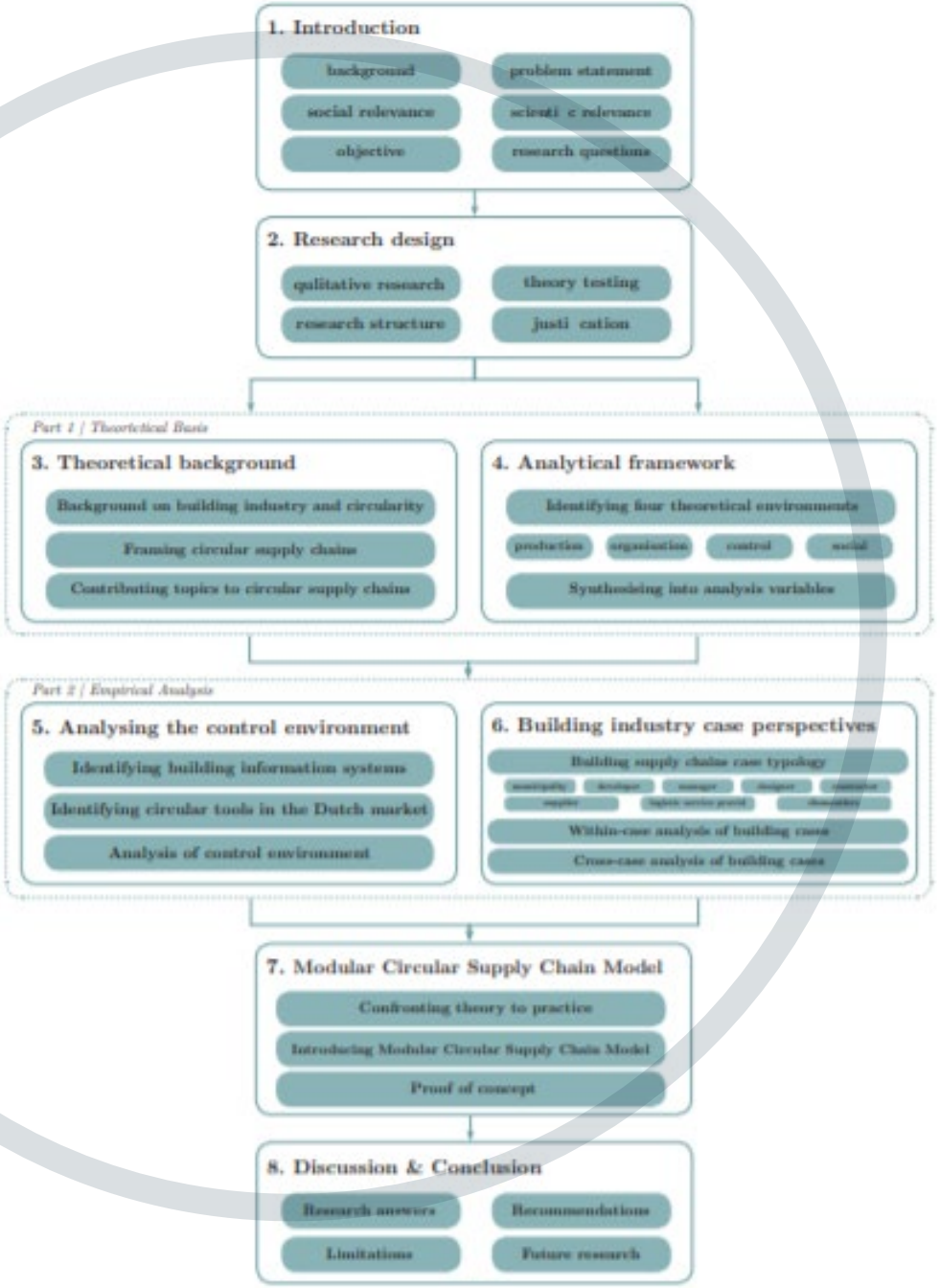
Empirical research with a case study approach

PART III

Proposing a Modular Circular Supply Chain Model (MCSCM)

CONCLUSION

Answering the research question(s) and providing limitations together with future research



METHODOLOGY

Coding process

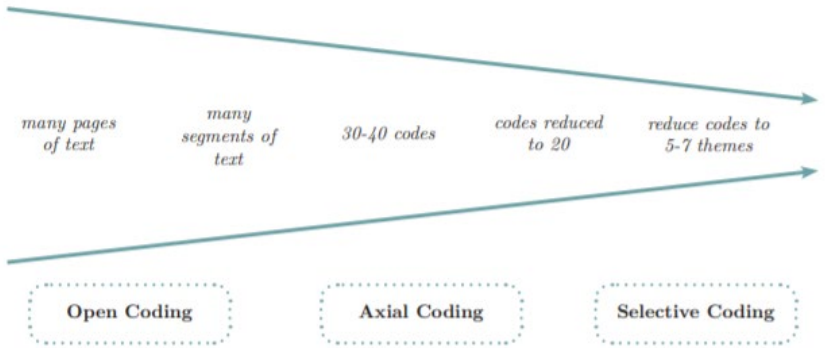


Figure 2-2: Overview of coding process: Open, Axial and Selective Coding (retrieved from Williams & Moser, 2019, p.47)

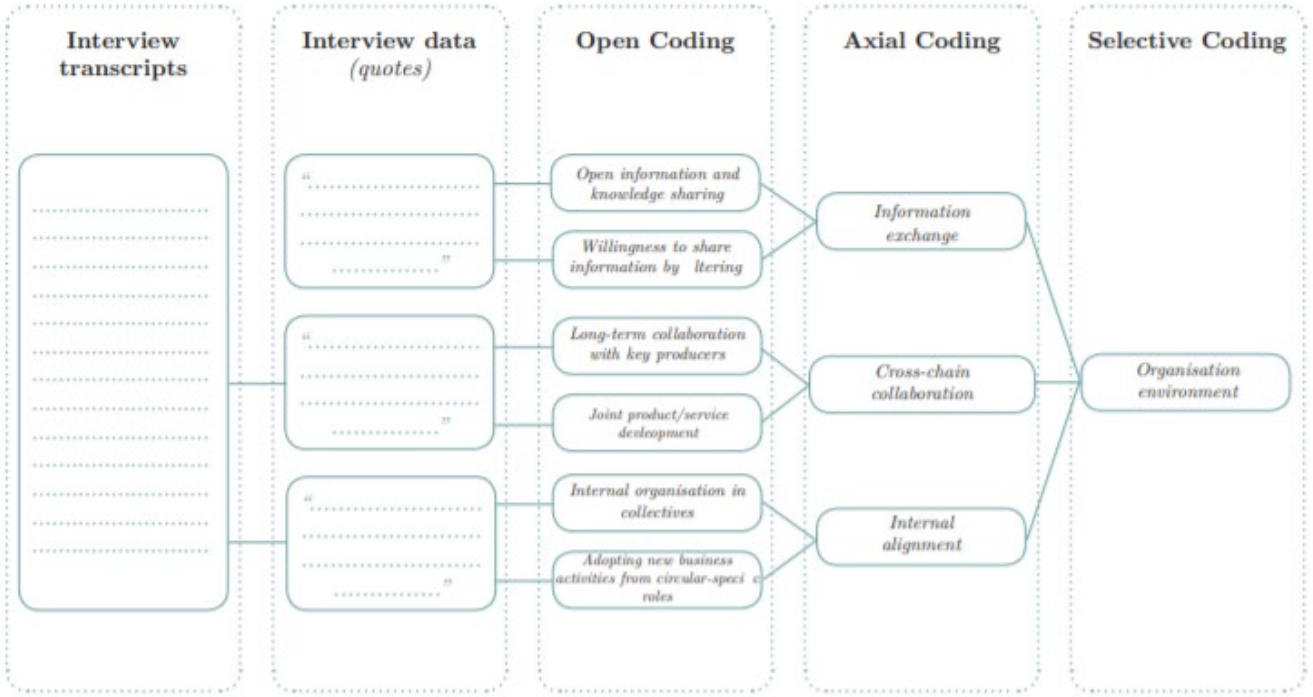


Figure 2-3: Example of the coding process

METHODOLOGY

Building case selecting criteria

- Relevant to the Dutch building sector
- Have interest and claim to support circular building
- Supply chain organisational functions cover different phases of the supply chain
- Circular applications are publicly accessible
- Willing to cooperate and share documents
- Involved in circular building projects

METHODOLOGY

Circular building tools selecting criteria

Table 4-1: Selecting criteria of circular tools (adapted from Cambier, 2020, p.3)

	Adopted criteria	Cambier's Criteria
(1)	Relevant to the Dutch context	Relevant for the Flemish building sector
(2)	Claim to support circular building	Claim to support circular building
(3)	Applicable and available for use	Available for use
(4)	Address different building stakeholders	Address building designers and advising engineers

EMPIRICAL ANALYSIS

Primary data | Building industry cases

- An *Esperanto language* is crucial to enable comparability and connectivity between tools.
- A virtual control *infrastructure* supports the *information sharing, coordination and collaboration* between stakeholders.
- If a control environment is facilitated by a *human controller*, it should be *an independent or governmental body*.
- Circular building tools ...

breaking barriers
EXAMPLE PROJECTS

Triodos Bank
Utrecht

Townhall Brummen
Brummen

Edge Amsterdam West
Amsterdam

Edge Olympic
Amsterdam

De Satelliet
Amsterdam

. . . .