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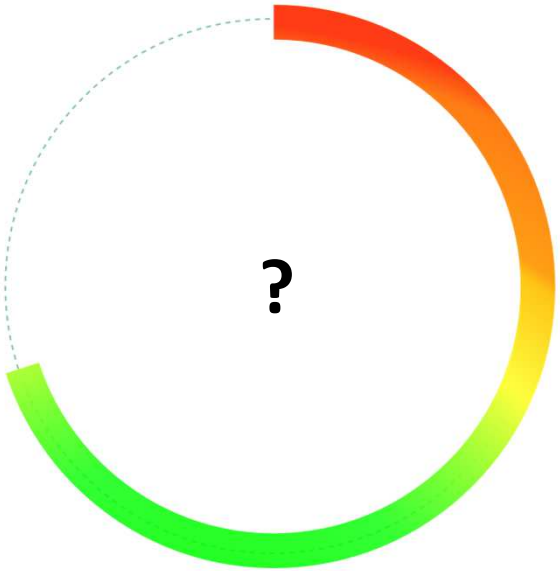
Rotterdam
Circulair
Gemeente Rotterdam

Closing the Loop

A Decision Support Framework for Circular Economy implementation to the adaptive reuse of buildings in the Netherlands

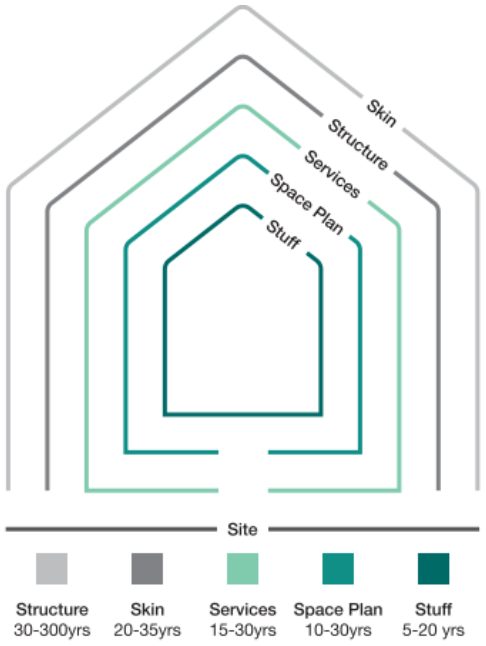

DISCOVER
PARTY
EAT
LOVE
RELAX
TWERK
PLAY
CREATE
THRILL
WORK
FUCK
SLEEP
DREAM
MIX
SWEAT


?

What to do ?

Three important concepts

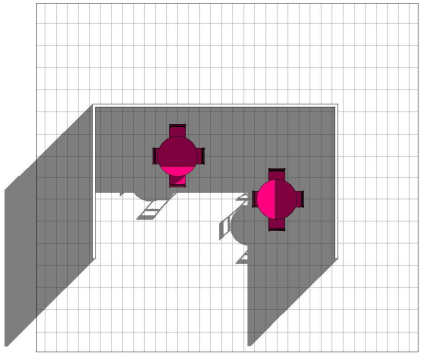
I. Building Layers (Brand, 1995)



(EMF, 2020)

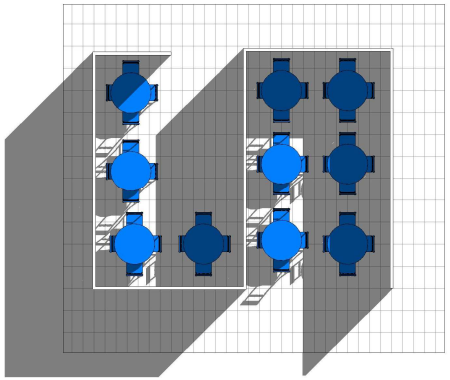
II. CE principles degree (bokken et al,2014)

1st use lifecycle



Recycle

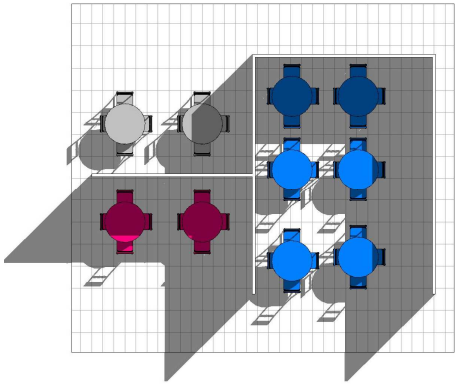
2nd use lifecycle



Recycle

Re-use

2nd use lifecycle



Recycle

Re-use

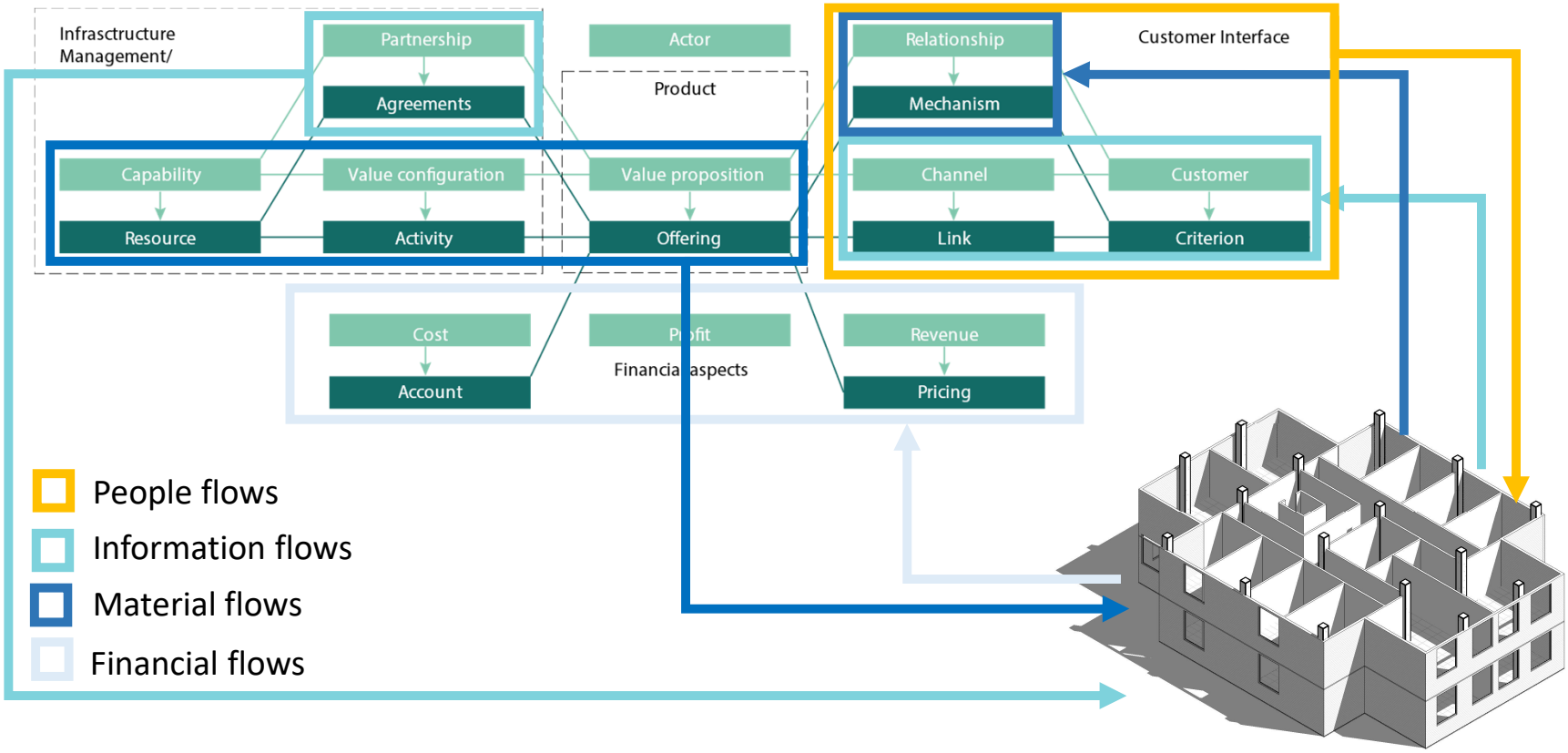
Share

III. Important processes for the project mission

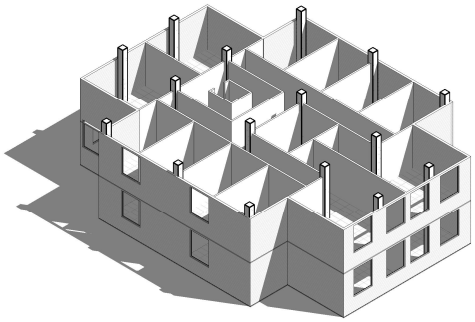
(winch, 2009).

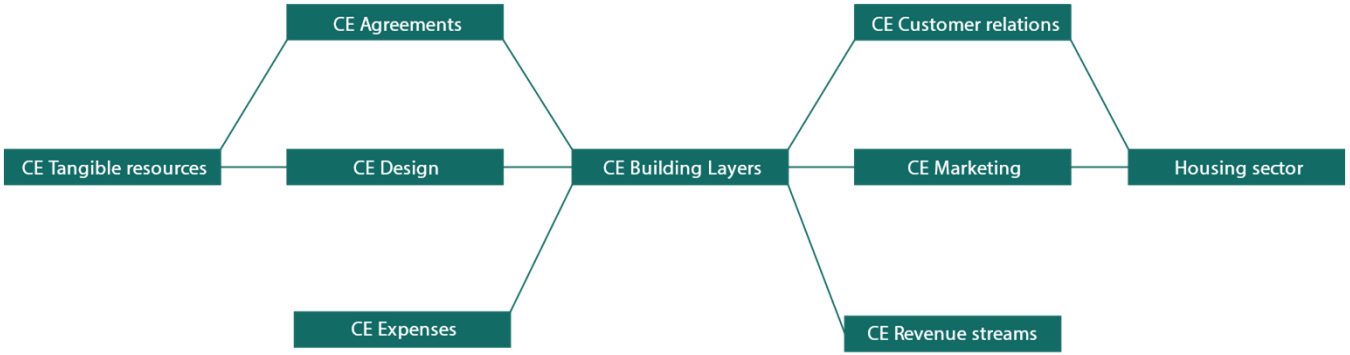
- **Information flow**
- **Material flow**
- **People flow (also information carriers)**
- **Financial Resource flow**

III. Business Model Canvas (Osterwalder, 2004)



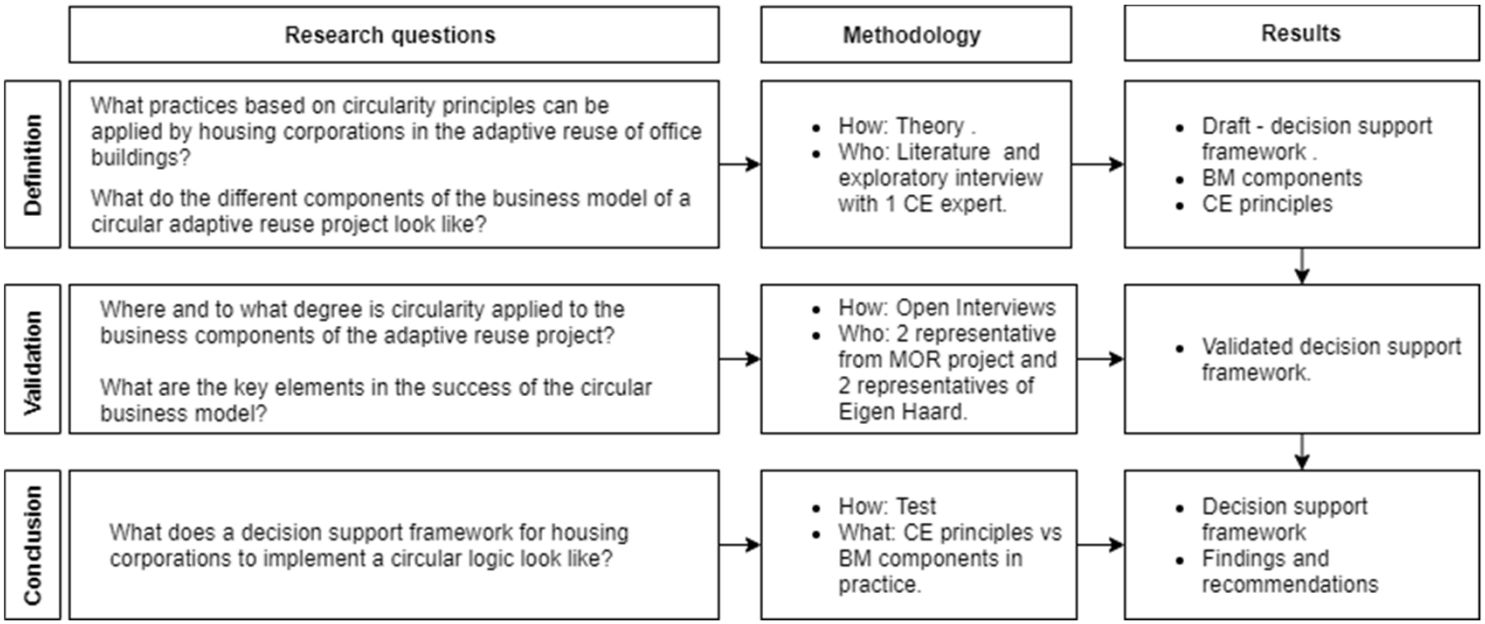
CASE STUDIES



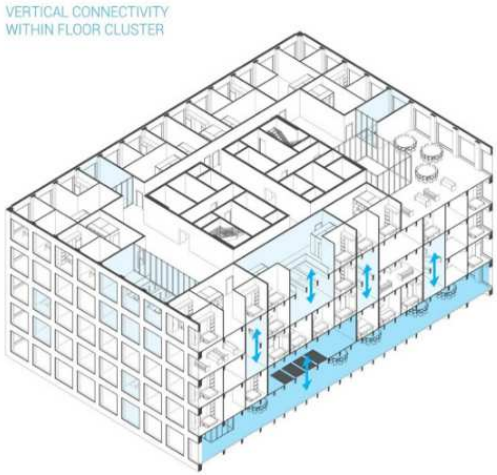


How can CE principles be applied in the business model for the adaptive reuse of office buildings?

Methodology

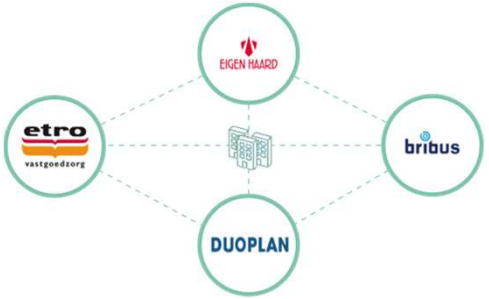


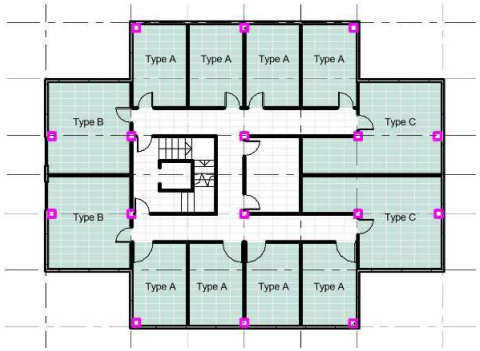
MOR



TU Delft


Noorderliefde
CIRCULAIR BOUWPROJECT
IN DIT VOORMALIGE KANTOORPAND REALISEREN
WIJ 30 SOCIALE WOONUNITS
etro
in opdracht van:

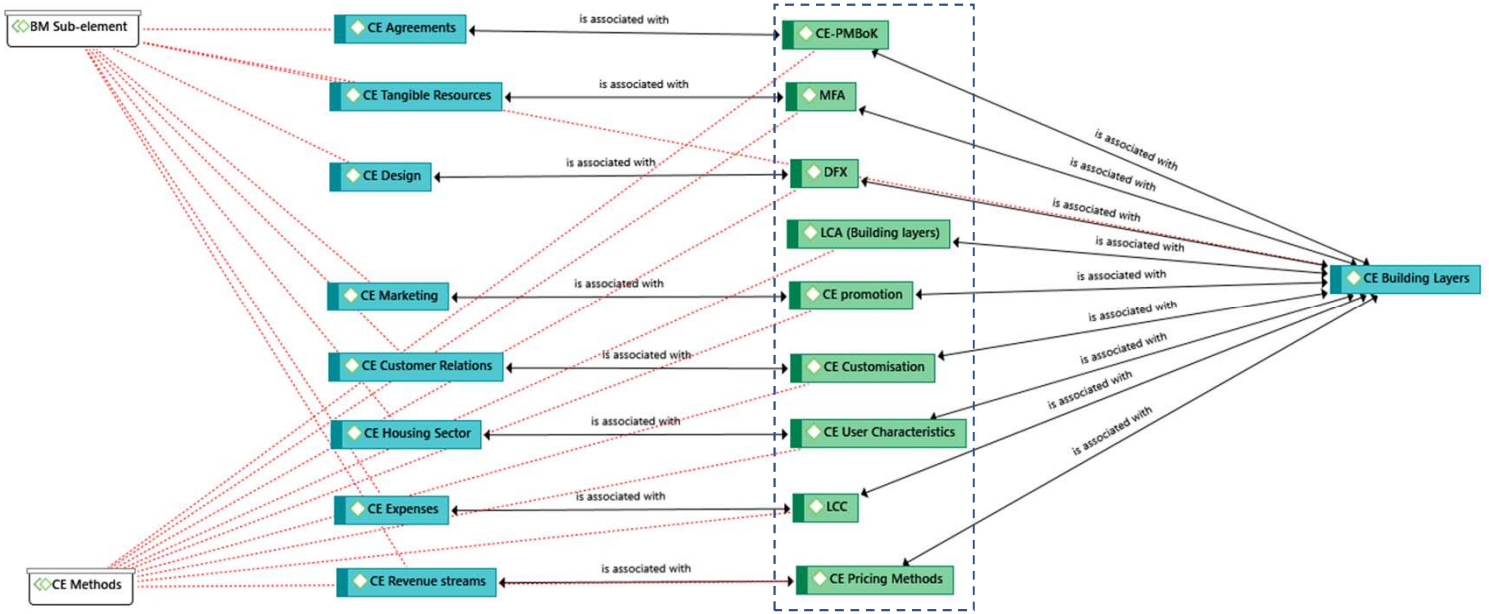

EIGEN HAARD
etro
vastgoedzorg
bribus
DUOPLAN

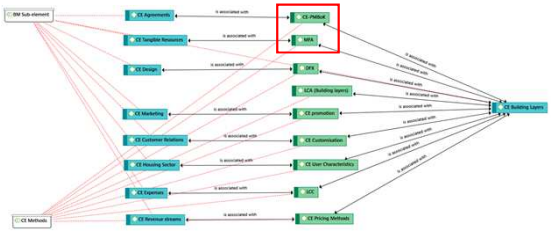

Type A
Type A
Type A
Type A
Type B
Type C
Type B
Type C
Type A
Type A
Type A
Type A

Results

CE METHODS

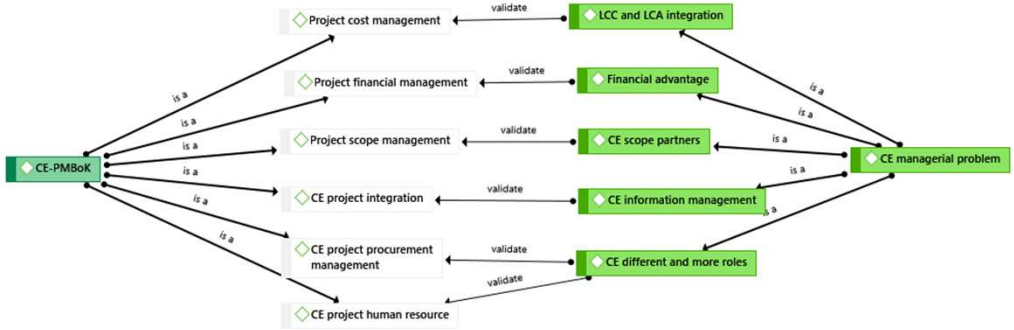
confront uncertainty and enable action.



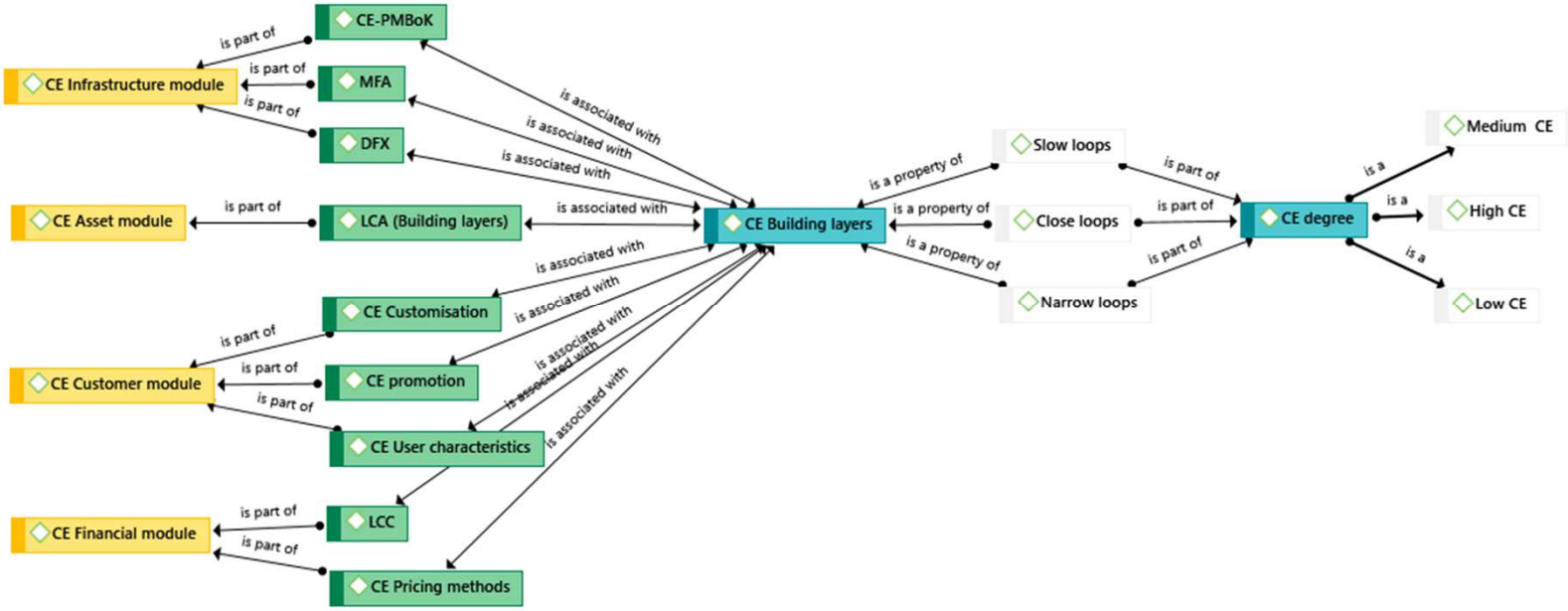


Literature

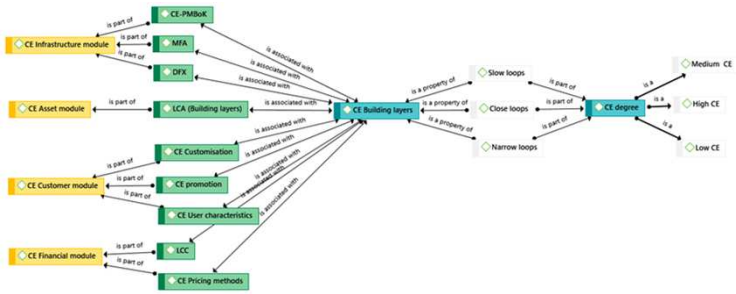
Interviews

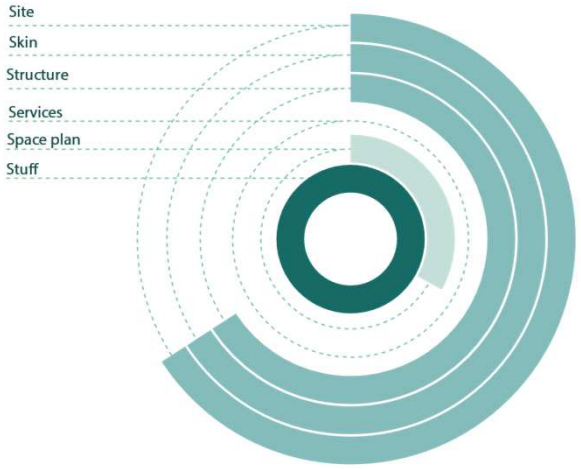


Decision support framework

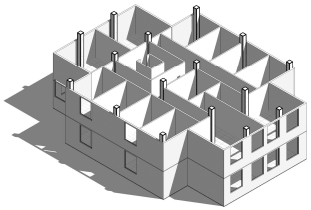


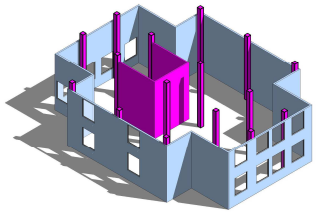
Noorderliefde Assessment

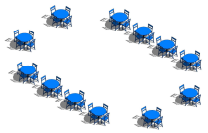


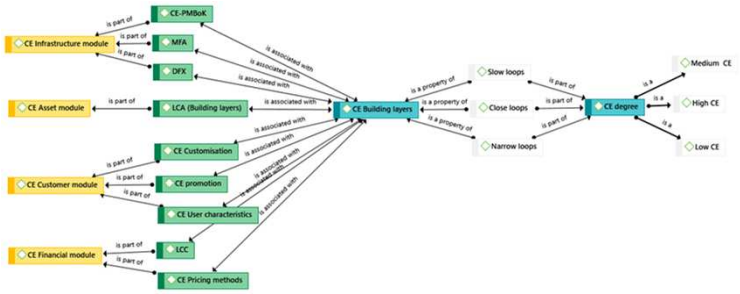


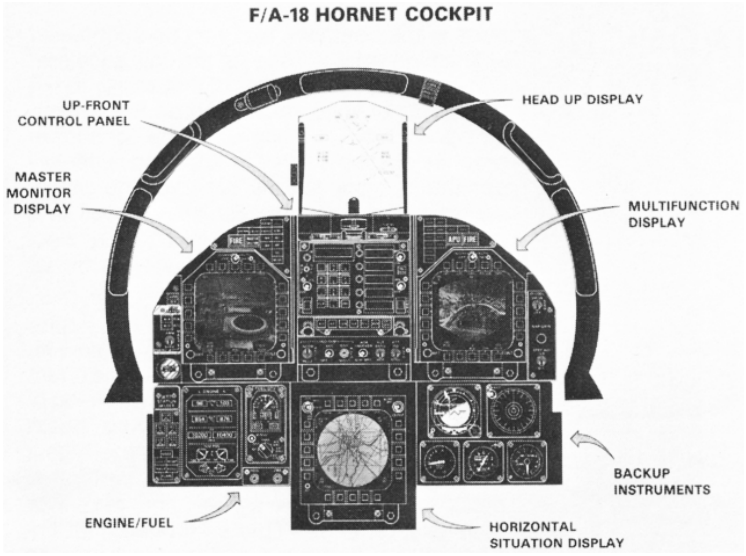
Infrastructure module (material flows)								
CE BM sub- element	CE Methods	Variables (tools)	Yes/No	CE building layer	CE degree		CE layers	Total CE degree
CE tangible resources	Material flow analysis	Material circularity index (MCI)	No	Structure	High	High	Structure	Medium
			No	Skin				
			No	Space p.				
			Yes	Stuff				
			No	Services				
			No	Site				
		Reusable+ material analysis	Yes	Structure	Medium		Skin	Medium
			Yes	Skin				
			No	Space plan				
			Yes	Stuff				
			No	Services			Space plan	Low
			Yes	Site				
CE design	Design for x	Design for narrowing resource loops	No	Structure	Low	High		
			No	Skin				
			Yes	Space plan				
			Yes	Stuff			Stuff	High
			No	Services				
			No	Site				
		Design for slowing resource loops	Yes	Structure	Low			
			Yes	Skin				
			No	Space plan			Services	None
			Yes	Stuff				
			No	Services				
			Yes	Site				
		Design for closing resource loops	No	Structure	Low			
			No	Skin				
			No	Space plan				
			Yes	Stuff				
			No	Services			Site	Medium
			No	Site				

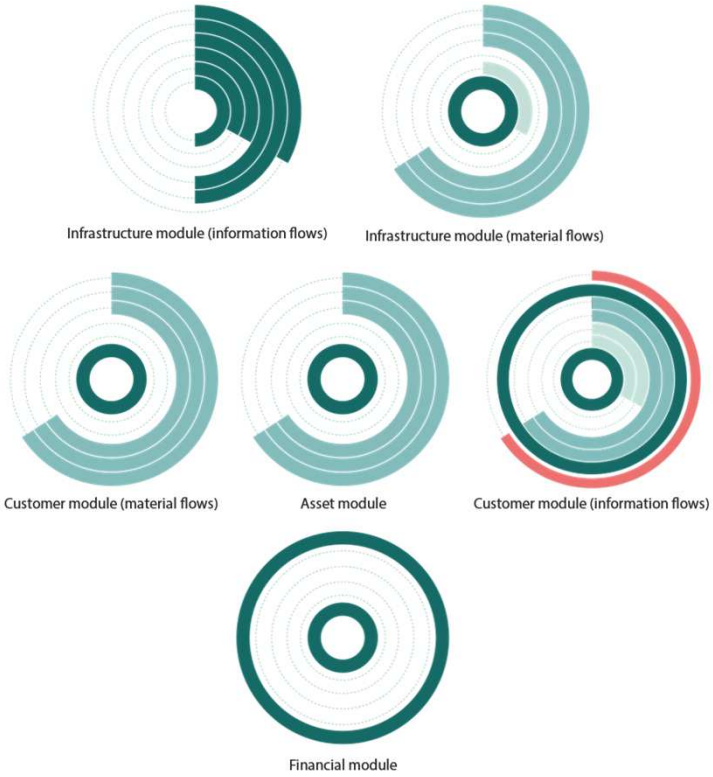


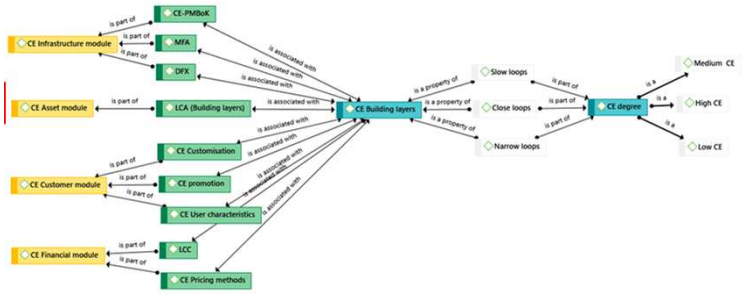


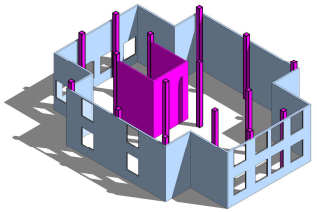


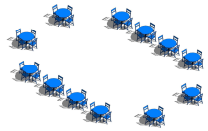

CE-PMBoK
CE Infrastructure module
MFA
DFX
CE Asset module
LCA (Building layers)
CE Building layers
Slow loops
Close loops
Narrow loops
CE degree
Medium CE
High CE
Low CE
CE Customisation
CE Customer module
CE promotion
CE User characteristics
CE Financial module
LCC
CE Pricing methods
is part of
is associated with
is a property of
is a

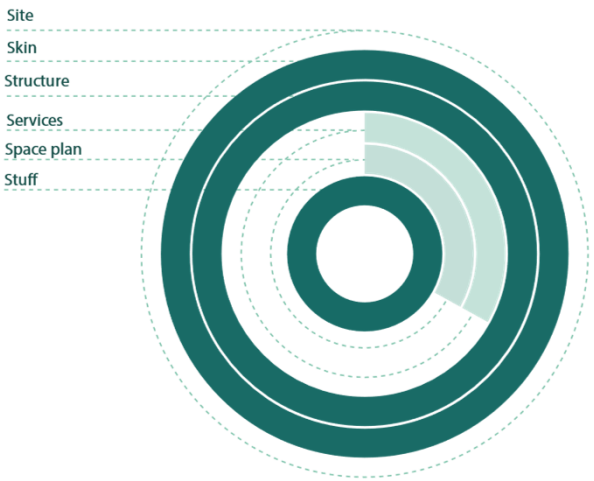

F/A-18 HORNET COCKPIT
UP-FRONT CONTROL PANEL
HEAD UP DISPLAY
MASTER MONITOR DISPLAY
MULTIFUNCTION DISPLAY
BACKUP INSTRUMENTS
ENGINE/FUEL
HORIZONTAL SITUATION DISPLAY


Infrastructure module (information flows)
Infrastructure module (material flows)
Customer module (material flows)
Asset module
Customer module (information flows)
Financial module





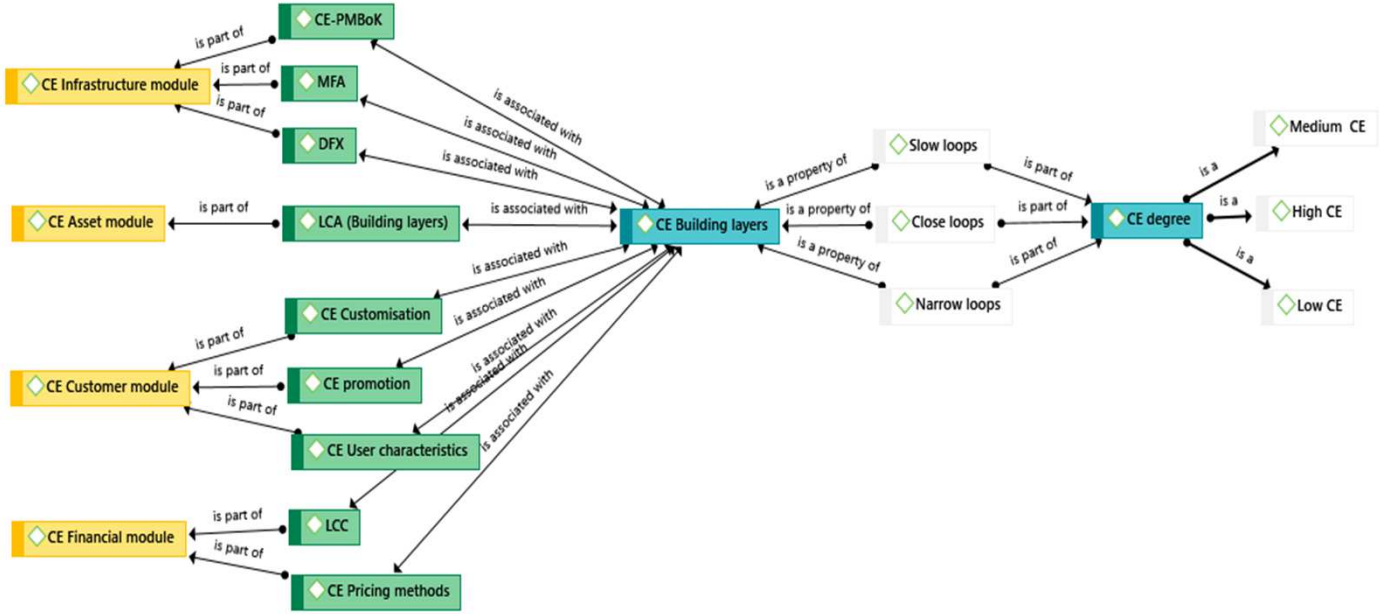




Asset module								
CE BM sub-element	Tot _CE Degree	CE Building layer	CE degree		CE Building Layer	Yes/No	Variables	CE Method
CE building layers	High	Structure	High	Medium	Structure	yes	Consecutive LCA (narrow and slow loops)	Lifecycle analysis (LCA)
	High	Skin			Skin	yes		
	Low	Services			Services	no		
	Low	Space p.			Space p.	No		
	High	Stuff			Stuff	yes		
	none	Site			Site	no		
				Low	Structure	Yes	Recycling end-of-life. (close loops)	
					Skin	yes		
					Services	yes		
					Space p.	no		
					Stuff	yes		
					Site	no		

Conclusions

How can CE principles be applied in the business model for the adaptive reuse of office buildings?

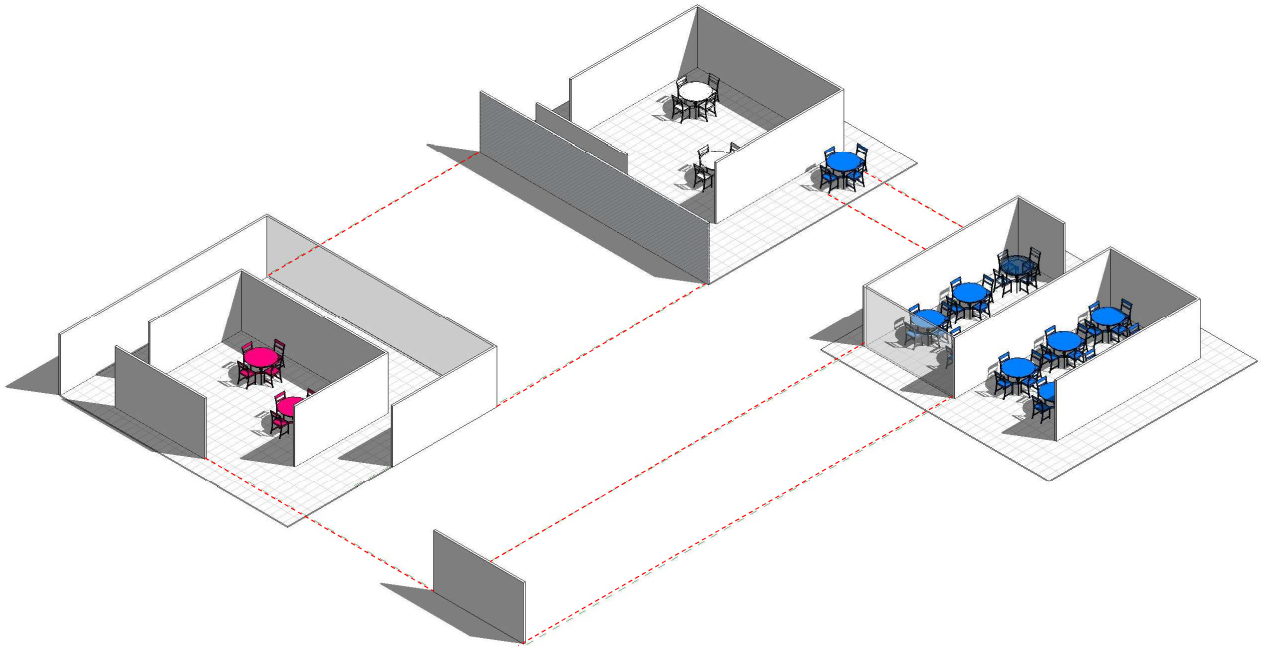


CE modules	CE BM sub-elements	CE methods	Variables	CE degree	Total_CE Degree
CE infrastructure module	CE agreements	CE-PMBoK	CE project long-term scope	High	High (6)
			CE project cost management	High	
			CE project procurement management	High	
			CE project integration management	High	
			CE project human resource	High	
			Financial management	High	
	CE tangible resources	MFA	Material circularity index. (MCI)	High	High
			Reusable+ material analysis	Medium	
	CE design	Design for x	Design for narrowing loops	Low	High
			Design for slowing loops	Low	
			Design for closing loops	Low	
CE Asset module	CE building layers	LCA	Consecutive LCA	Medium	High
			Recycling end-of-life	Low	
CE Customer module	CE marketing	CE promotion	CE social media	Medium	High
			CE publications	Medium	
			CE website media	Low	
			CE in-store communication	Low	
	CE housing sector	CE user characteristics	User as owner	Low	Low
			User as customer	Low	High
			Ownership as long-term investment	Medium	
			Circular stakeholder as owner	High	
	CE customer characteristics	CE customisation	CE cooperation	Medium-High	High
			Adaptable building layers	Medium	
			Relocatable building layers	Medium	
			Flexible building layers	Medium	
			Recyclable building layers	Low	
Financial module	CE expenditure	LCC	Lifecycle costing LCC - LCA	High	High
	CE revenue streams	Pricing methods	Product service systems (PSS) of “clean” products	High	High
			Buy- and take-back	High	
			Material commodities	Medium	Medium

Recommendations

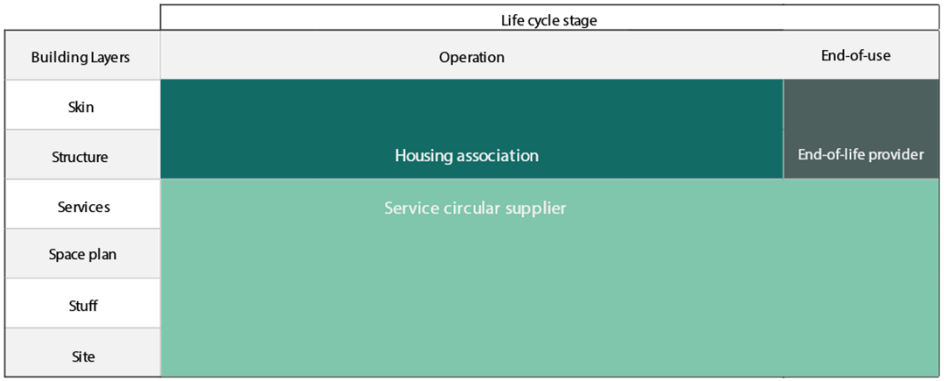
Relocatable building layers 12 step plan

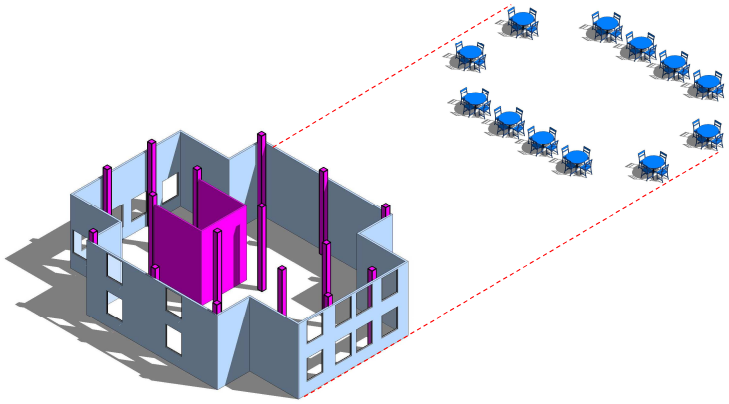
No.	Required activities	Variables
	Infrastructure module	
1	Assign relocation operator	CE project procurement management, CE project human resource & CE scope
2	Identify end-of-life service providers	
3	Establish operating agreements with municipalities	
4	Storage requirements if needed	
5	Develop maintenance plan	CE project long-term scope
6	Component database across portfolio	Project integration management and MCI
7	Developed design for: modularity, disassembly and transportation	Design for narrowing loops
		Design for slowing loops
		Design for closing loops
	Asset & customer modules	
8	Involve tenants and project managers in placemaking strategies	CE cooperation
		Adaptable building layers
		Relocatable building layers
		Flexible spaces
9	LCA to establish targets	Consecutive LCA
10	Define destination of building layer at end of life	End-of-life provider
	Financial module	
11	Rent customised building layers to social sector	Product as a service
12	Integrate lifecycle analysis and lifecycle cost (LCA and LCC) to set targets	LCC - LCA



Building layers as a service 10 step plan.

#	Required activities	Variable
Infrastructure module		
1	Develop CE agreements with service providers.	CE project procurement management, CE project human resource & CE scope
2	Identify end-of-life contractors for owned building layers	
3	Build consortia with service suppliers for building layers	
4	Establish operating agreements with service providers	
5	Develop operation and maintenance strategies considering Material Flow Analysis	Implement Material Circularity Index
6	Developed design for: modularity, disassembly, and transportation	DF Narrowing loops
		DF Slowing loops
		DF Closing loops
Asset & customer modules		
7	Engage tenants and project managers in placemaking strategies	CE Cooperation
		Adaptable Building Layers
		Relocatable Building Layers
		Flexible Spaces
8	LCA to establish targets	Consecutive LCA
		End-of-life provider
Financial module		
9	Rent customised building layers to social sector	Product as a service
10	Integrate LCA and LCC to establish targets	LCC - LCA





This research show how the connection between architecture and business processes can lead finally to the implementation of the Circular Economy in the build environment

Thank you!