
Circularity potential in building adaptation projects and building demolition projects

A tool to measure what the circularity potential of a building adaptation project or demolition project is

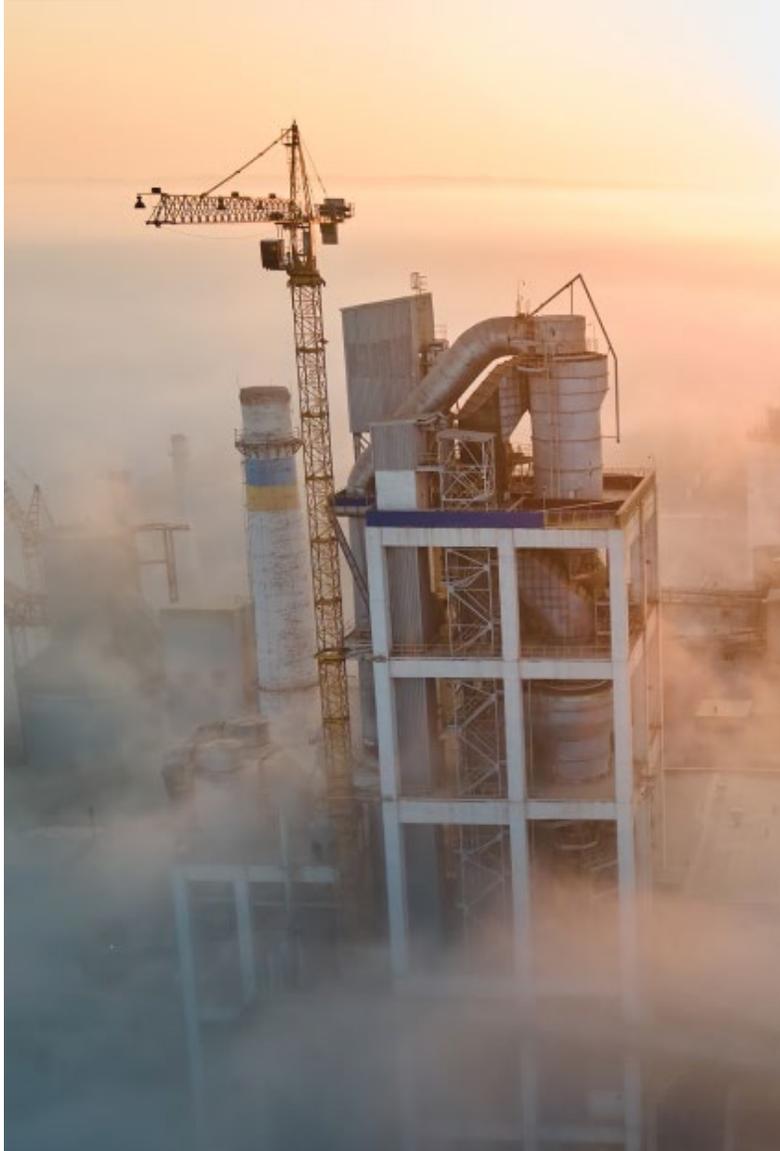


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Research problem





Research Problem

- Confusion around circular economy principles and how to apply them in the built environment (Lacy & Rutqvist, 2015)
- ‘Lack of awareness, knowledge and experiences with CE’ (Cetin et al., 2021)

Research gap



Currently, there are no easy or straight forward ways to identify which circular strategies can be applied in projects, and what factors or aspects these strategies could be based on, and also what the impact of these strategies would be

Main research aim

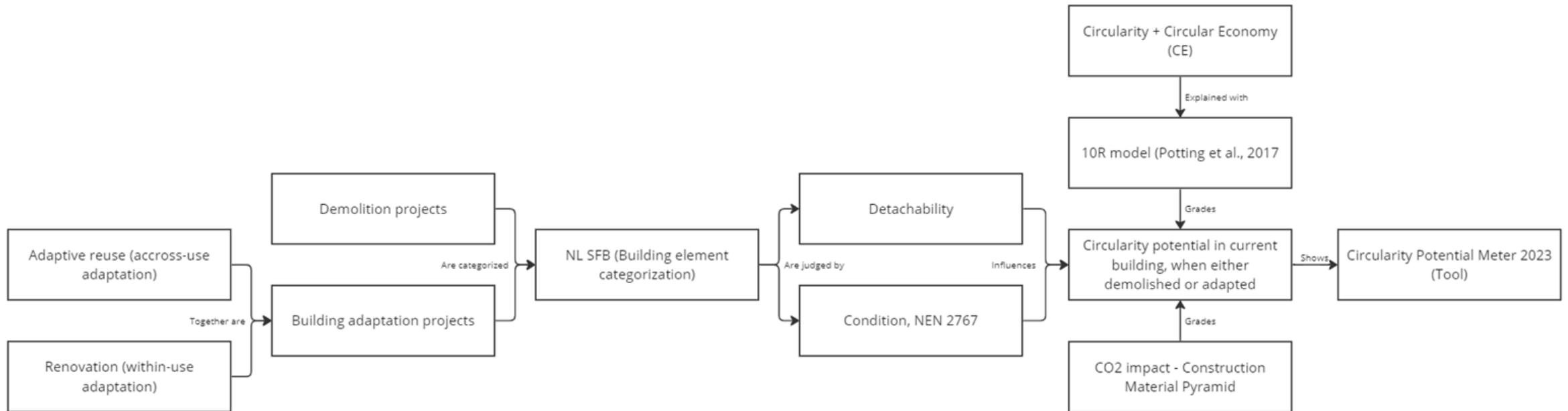
“To develop a tool which measures and identifies what the circularity potential of building adaptation projects and building demolition projects is.”

Questions to achieve research aim

- **SQ1:** What is building adaptation and demolition?
- **SQ2:** What is circularity/circular economy and how can it be applied in the built environment?
- **SQ3:** To which building elements can circularity in the built environment be applied?
- **SQ4:** Which tools/frameworks already exist to measure the adaptation potential and circularity potential of a building?
- **SQ5:** What choices (possibilities) are added to the decision-making process when you add circular strategies to the question about how to adapt or demolish a building?
- **SQ6:** Who are the users of the Circularity Potential Meter and what are their viewpoints on the usability, benefits and complications regarding the tool?



Conceptual model



Empirical research

- Spoken to 44 individuals, spread out over 67 exploratory interviews
- All exploratory interviews were spread out over a total of 9 companies
- 2 in depth interviews were conducted
- 4 project visits were conducted
- The tool has been tested out once, with one more planned in

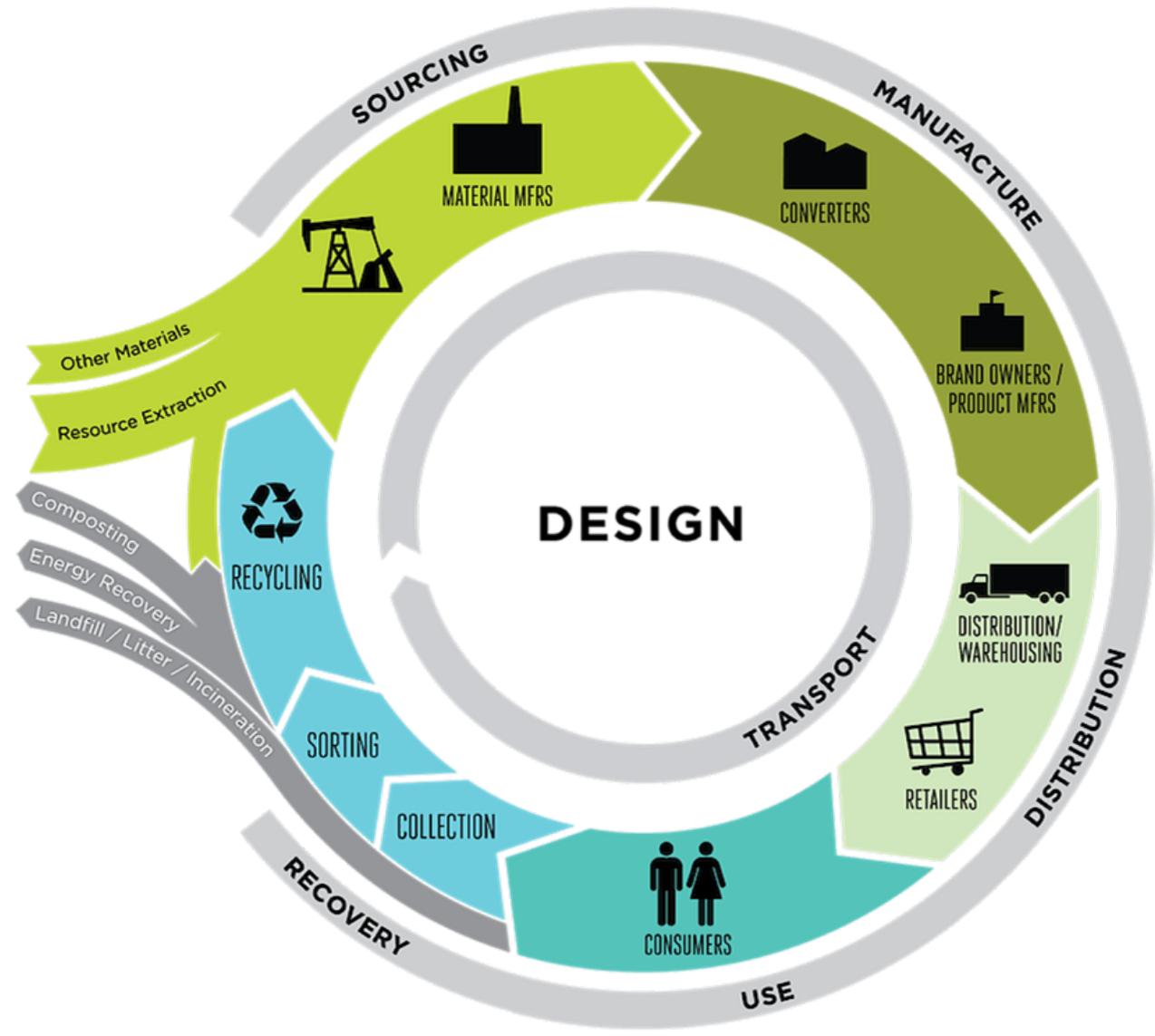
Research and results



Building adaptation and demolition



Circularity



10R Framework

- R0, Refuse: Refuse/prevent loss of value
- R1, Reduce: Use less resources
- R2, Redesign: Redesign with a circular mindset
- R3, Reuse: 1 on 1 reuse (2nd hand). Dismount element, transport for direct reuse
- R4, Repair: Maintenance and repairs. Dismount element, transport, repair before reuse
- R5, Refurbish: Fix up product. Dismount element, transport, fix up / modernise product before reuse
- R6, Remanufacture: create a new product from 2nd hand products. Dismount element, transport and apply product in element with the same function.
- R7, Repurpose: Reuse the product for something else. Dismount element, transport and apply product in element with different function.
- R8, Recycle high value: Reuse resources.
- R9, Recycle low value: downcycle resource.
- R10, Recover: Energy recovery

Circular economy

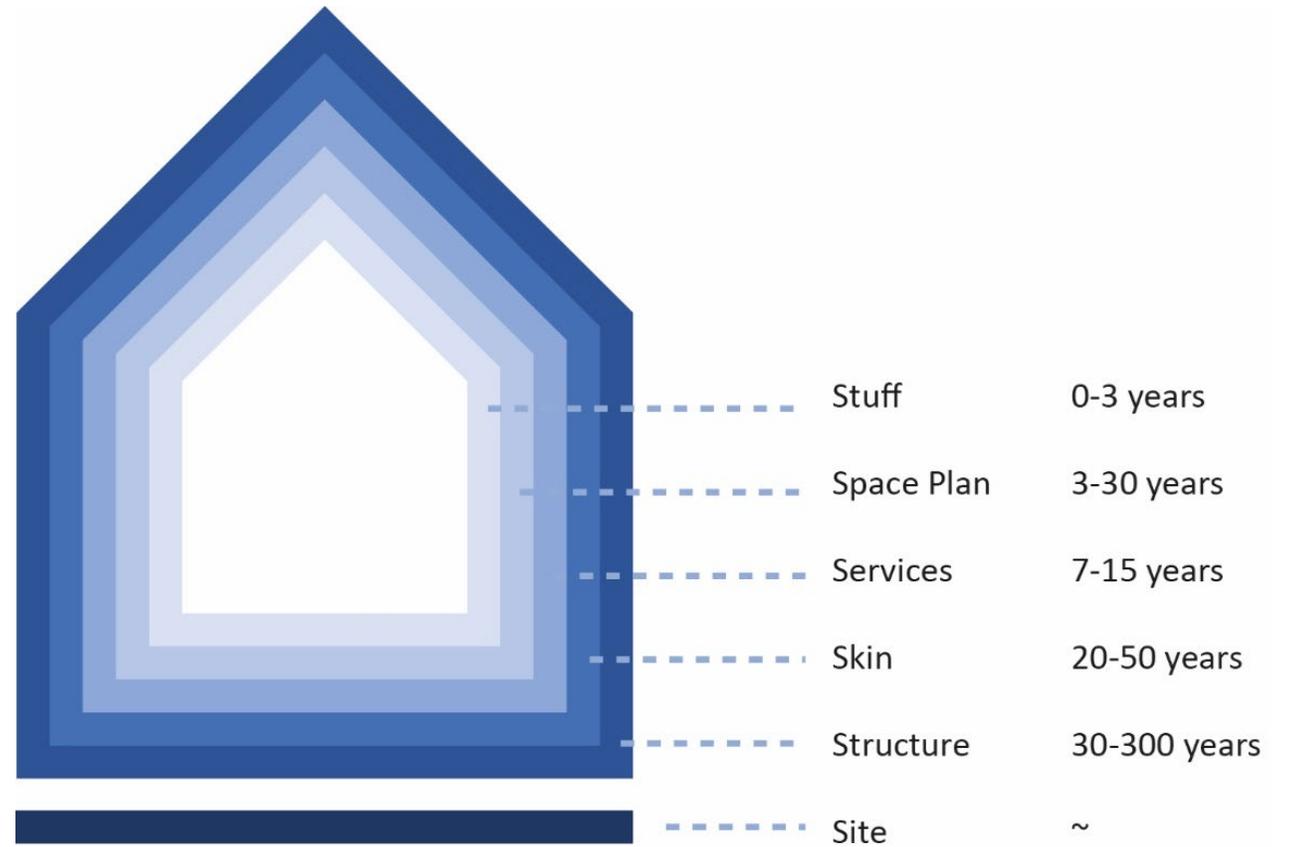
Increasing circularity

Rule of thumb:
Higher level of circularity = fewer natural resources and less environmental pressure

Linear economy

Smarter product use and manufacture	R0 Refuse	Make product redundant by abandoning its function or by offering the same function with a radically different product
	R1 Rethink	Make product use more intensive (e.g. through sharing products, or by putting multi-functional products on the market)
	R2 Reduce	Increase efficiency in product manufacture or use by consuming fewer natural resources and materials
Extend lifespan of product and its parts	R3 Re-use	Re-use by another consumer of discarded product which is still in good condition and fulfils its original function
	R4 Repair	Repair and maintenance of defective product so it can be used with its original function
	R5 Refurbish	Restore an old product and bring it up to date
	R6 Remanufacture	Use parts of discarded product in a new product with the same function
	R7 Repurpose	Use discarded product or its parts in a new product with a different function
Useful application of materials	R8 Recycle	Process materials to obtain the same (high grade) or lower (low grade) quality
	R9 Recover	Incineration of materials with energy recovery

Brand Layers

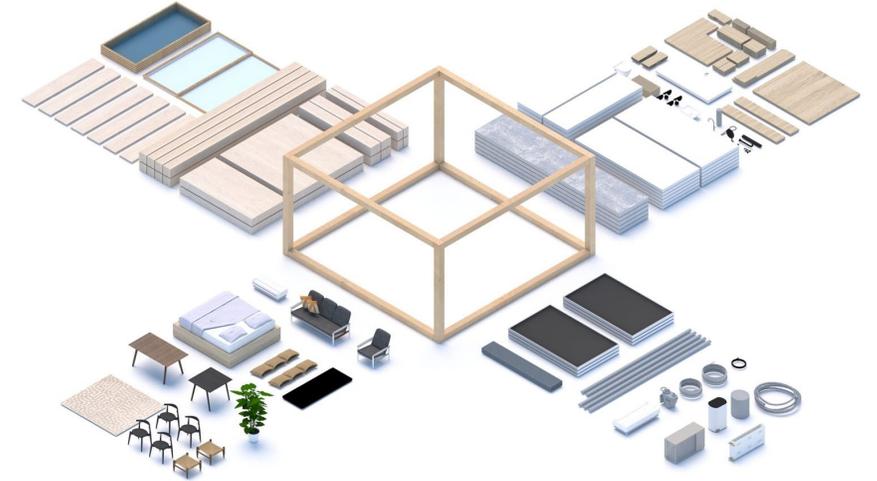


NL SFB

1. Ground substructure
2. Structure primary elements, carcass
3. Secondary elements, openings
4. Finishes
5. Services, mainly mechanical
6. Services, mainly electrical
7. Facilities
8. Fittings
9. Ground facilities

Code	Description	Code	Description
Ground, substructure		53	Water
11	Groundwork	54	Gas
13	Floor beds	55	Cold generation and distribution
16	Retaining walls, foundations	56	Heat distribution
17	Pile foundations	57	Air treatment
Structure primary elements, carcass		58	Monitoring climate and sanitary
21	External walls	Services, mainly electrical	
22	Internal walls	61	Electrical supply
23	Floors	62	Power
24	Stairs and slopes	63	Lighting
27	Roofs	64	Communication
28	Building frames	65	Security
Secondary elements, openings		66	Transport
31	External wall openings	67	Building monitoring facilities
32	Internal wall openings	Facilities	
33	Floor openings	71	Traffic facilities
34	Balustrades, handrails	72	User facilities
37	Roof openings	73	Food processing facilities
38	Built-in system	74	Sanitary facilities
Finishes		75	Maintenance facilities
41	External wall finishes	76	Storage facilities
42	Internal wall finishes	Fittings	
43	Floor finishes	81	Traffic fittings
44	Stair and slope finishes	82	User fittings
45	Ceiling finishes	83	Food processing fittings
47	Roof finishes	84	Sanitary fittings
48	Finish packages	85	Maintenance fittings
Services, mainly mechanical		86	Storage fittings
51	Heat generation	Ground facilities	
52	Drainage	90	Ground facilities

Disassembly potential and condition



Condition score NEN 2767-1:2017 (and further)						
Flaw	Intensity	Scale				
		< 2% incidentally	2 - 10% locally	10 - 30% regularly	30 - 70% considerably	> 70% regularly
Minor flaw	Beginning	1	1	1	1	2
	Advanced	1	1	1	2	3
	End	1	1	2	3	4
Serious flaw	Beginning	1	1	1	2	3
	Advanced	1	1	2	3	4
	End	1	2	3	4	5
Very serious flaw	Beginning	1	1	2	3	4
	Advanced	1	2	3	4	5
	End	2	3	4	5	6

Condition (NEN 2767)

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Construction Material Pyramid

choose impact category
Global Warming Potential (GWP)

choose unit
m³

filter by material group
no filter

filter and sort by "functional unit"
according to declared unit

Kg CO₂ per m³

[GWP [kg CO₂ eq / m³]
[module A1-A3]



Construction Material Pyramid (Beim & CINARK, 2021)

Circular economy

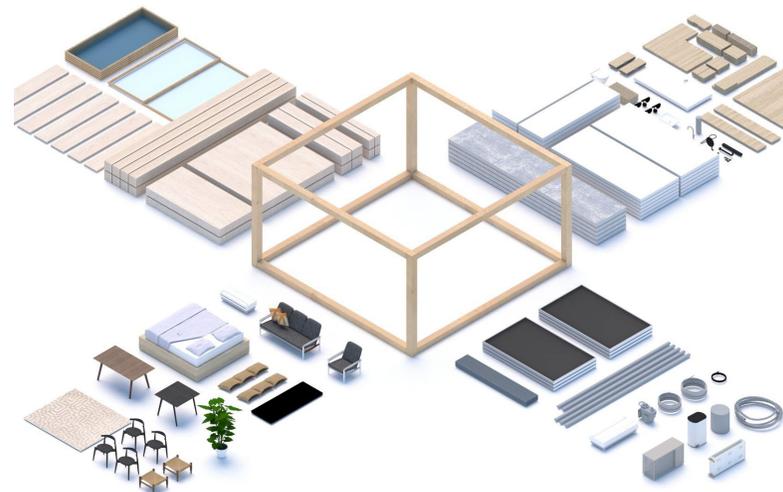
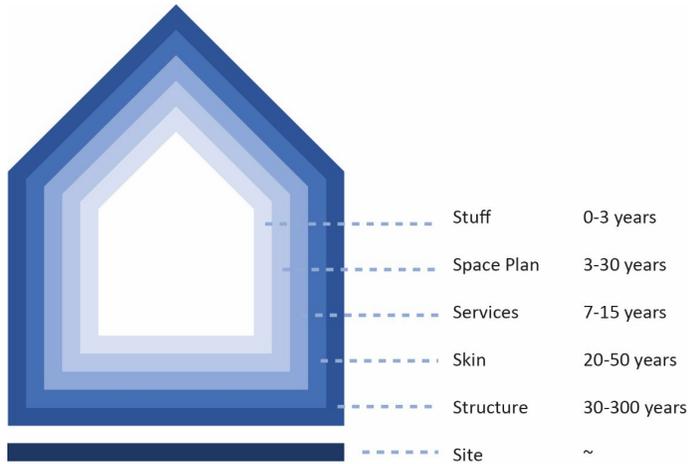
Increasing circularity

Rule of thumb: Higher level of circularity = fewer natural resources and less environmental pressure

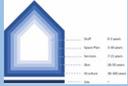
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		<h1>Circulaire potentie van het gebouw</h1>		
Aspect, NL SFB	Brand lagen	Gebouwelementen specifiek	Materiaal	Ander materiaal
Funderingen	Site	11.1 Bodemvoorzieningen, grond		
	Site	11.2 Bodemvoorzieningen, water		
	Space plan	13.1 Vloeren op grondslag, niet constructief		
	Structure	13.2 Vloeren op grondslag, constructief		
	Structure	16.1 funderingsconstructies; voeten en balken	Concrete C30/37	
	Structure	16.2 funderingsconstructies; keerwanden		
	Structure	17.1 paalfunderingen; niet geheid		
Structure	17.2 paalfunderingen; geheid			
Ruwbouw	Skin	21.1 buitenwanden; niet constructief		
	Structure	21.2 buitenwanden; constructief		

- Slate
- Aluminum frame window
- Brick, red, double-fired
- PIR insulation
- Wood-Aluminum frame window
- Fibre cement boards
- Clinker - stoneware
- Brick, red, single-fired



						Kg CO2 per m3
					Filled in based	
Materiaal	Ander materiaal	Hoeveelheid	eenheid	+/- M3		CO2 Impact
			m3			
			m3			
			m2			
			m2			
Concrete C30/37		300	m1	30		8.640
			m1			
			Units			
			Units			
					Tot CO2 impact	8.640

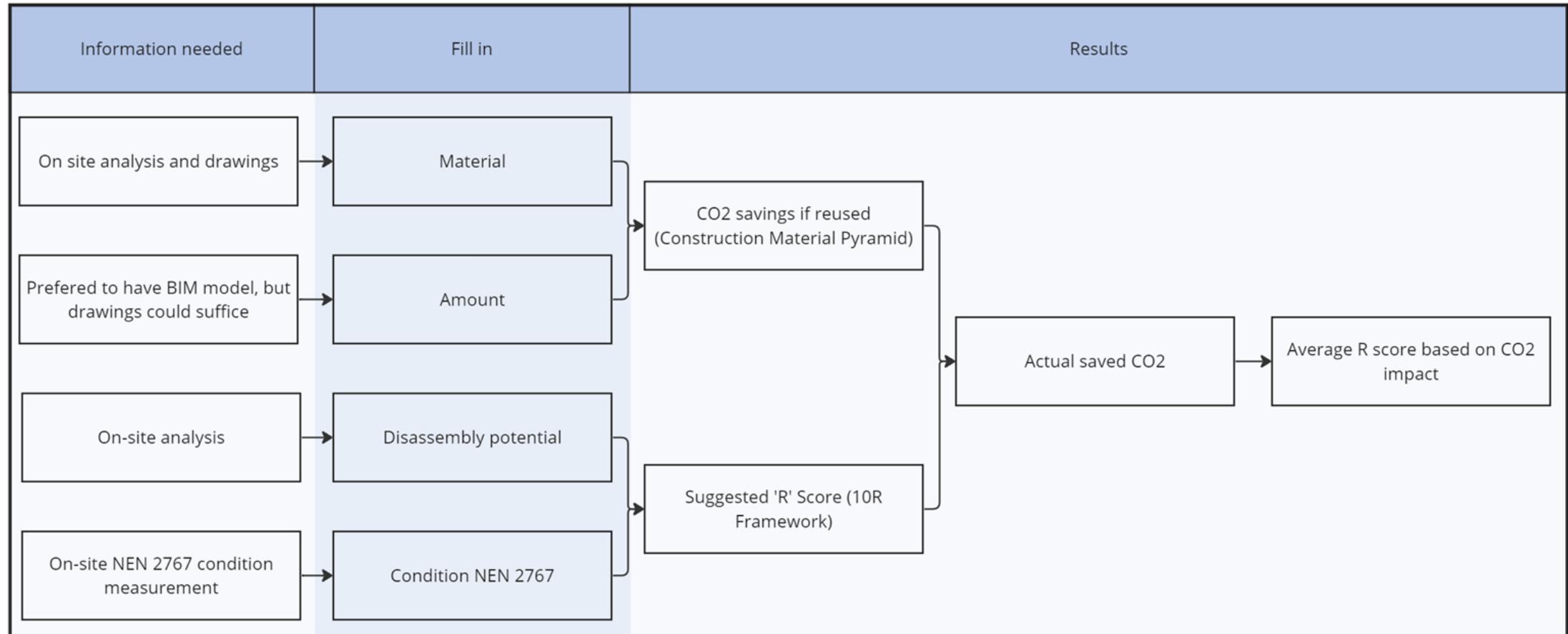
	Refuse	Rethink	Reduce	Re-use	Repair	Refurbish	Remanufacture	Repurpose	Recycle	Recover				
R	R0	R1	R2	R3	R4	R5	R6	R7	R8	R9	R0-R9	R' score based on CO2	CO2 Impact if R3	CO2 impact based on R score
R6				80%	20%						3,2		16.950	11.865
R3				100%							3		1.063.120	1.063.120
R8									100%		8		141.210	70.605
R4					100%						4		38.100	34.290
R5						100%					5		18.960	15.168
R7								100%			7		5.700	3.420
R5						100%					5		5.320	4.256
R4					100%						4		5.580	5.022
R4					100%						4		6.510	5.859
R5						100%					5		84.700	67.760
R7								100%			7		47.400	28.440
R8									100%		8		450	225
R4					100%						4		13.550	12.195
R5						100%					5		46.860	37.488
										Gem. R	5,2	3,6	1.494.410	1.359.713

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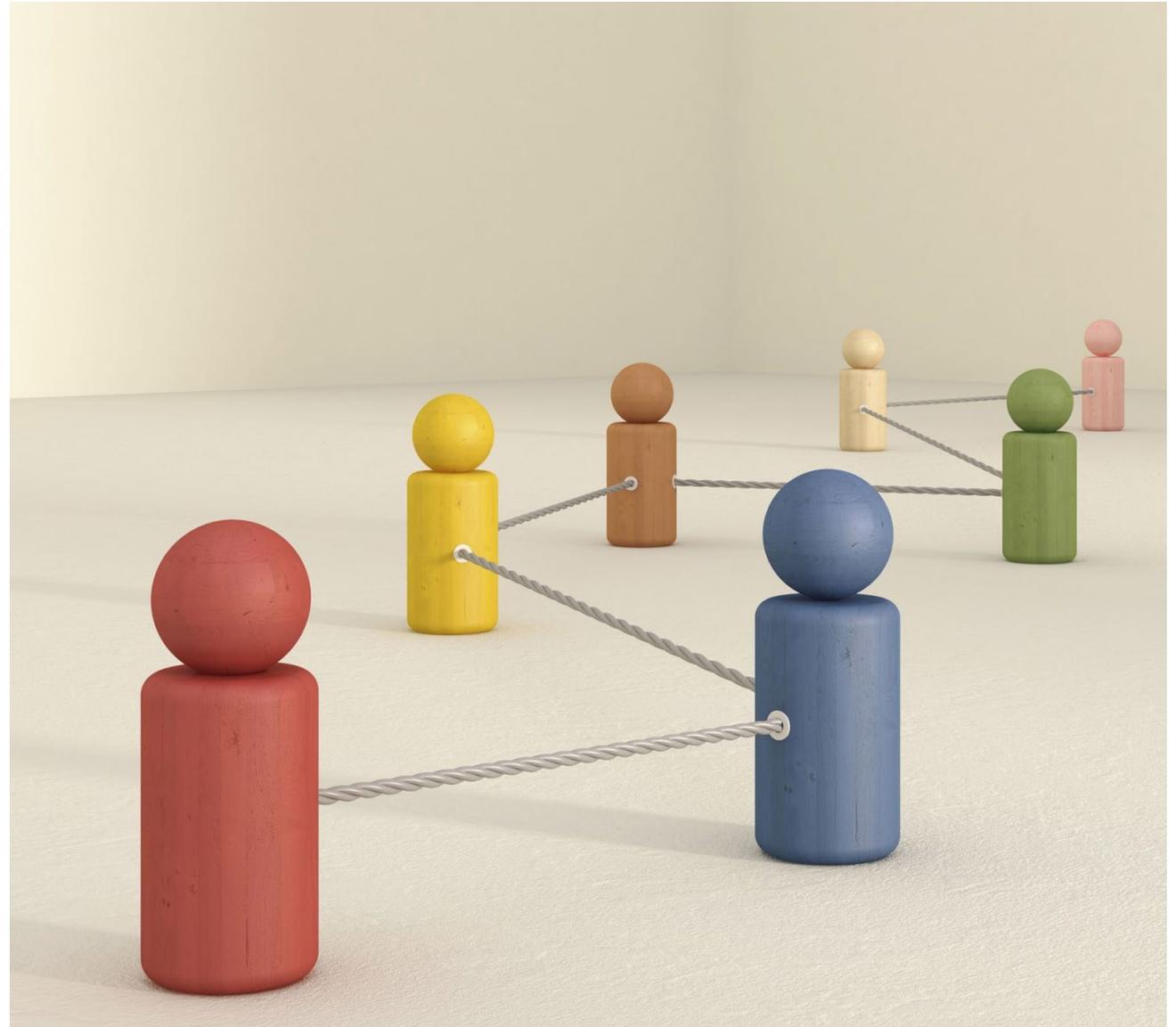
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Research and results



Users

- Consultancy firms
- Contractors
- Clients
- Architects



Conclusion - Discussion

- Main research aim
- More testing
- Suggestions
- Indicative
- No financial indication
- Background knowledge
- Qualitative research
- Passed on





Introduction

On the real estate market, there will always be a demand for newly constructed real estate. Demand and supply are never quite in balance, meaning that the construction of new real estate will always exist. Solutions to satisfy the demands on the real estate market are often sought by constructing new real estate. However, even though 87% of the needed buildings in 2050 have already been built, the already existing building stock is often overlooked when trying to satisfy demands. (Wilkinson & Remoy, 2017). This is where building adaptation and

Main takeaways

In order to develop a tool which identifies what the circularity potential in building adaptation projects and building demolition projects is, a good understanding of factors which determine circularity potential is essential. In order to gain this understanding

Questions?

