Appendices

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Appendix A. Interview protocol

This appendix provides a detailed outline of the interview protocol used in the study, including the introduction, main questions, and the approaches involving the COM-B model. It is structured to extract nuanced insights about the adoption of circular design practices within the wastewater department, focusing on the perspectives, experiences, and recommendations of the engineers involved.

Introduction

1. Introduction to interviewer and study – Jeanine de Jong, BSc Mechanical Engineering and MSc student Engineering and Policy Analysis.
2. Research objective – Formulate recommendations on stimulating adoption of circular design among engineers at the wastewater department
3. Purpose of the interview –
    - To understand the current circularity practices and perceptions within the company and the current use of circular design.
    - To identify barriers and drivers of on applying circular design
    - To investigate the preferred and effective manner of support in encouraging circular working
4. Structure of interview –
    - General questions on position and role within projects.
    - Utilisation of the AIDA model to see where participants stands in circularity.
    - Utilisation of COM-B to question on implementation and methods of intervention which are preferred and effective, or not.
5. Interview type –
    - Semi-structured, meaning that some questions are prepared, but not necessarily all asked or in a consequent order.
    - Potentially questions and answer will be follutwed up with additional questions
    - Encouragement to speak freely whenever something is seen as relevant to applying circular design principles.

6. Recording and Transcription –
    - Recorded with Teams
    - Transcription of interview will be send to be approved by participant
7. Provide and explain informed consent form and request to sign

Questions

The conversations were in Dutch, and therefore the questions below as well as.

Opening questions on function, role and circularity

Functie

- Zou je je functie willen omschrijven?
- Hoeveel ervaring heb je in je huidige functie?
    - Ben je goed in je werk?
    - Voel je je ervaren of zelfverzekerd?
- Wat zijn je werkzaamheden?

RWZI

- Welke onderdelen van een RWZI heb je invloed op?
- In welke fase heb je daar invloed op?

Circulariteit

- Wat omvat in jouw beleving circulariteit?

Proces

- De gesprekken over welke keuzes gemaakt worden bij RZWI ontwerpen, wie maakt daarin de uiteindelijke keuzes?

AIDA-model

Adapted AIDA model inspired by Customer Journey Mapping

1. Explanation of AIDA model
2. Sidenote that this model is intended for inspiration, to give participants words on engagement phases. It does not necessarily have to be in the order, nor does it necessarily have to be these phases. Please feel free to interpret it differently if desired.

Questions:

- Wanneer en hoe kwam je in aanraking met circulariteit?
- Hoe heb je circulair ontwerpen voor het eerst ontdekt?
- Wat motiveert je om circulair ontwerpen te gebruiken?
- Wat waren de hoogtepunten en uitdagingen bij circulair ontwerpen?
- Wat zijn de behoeften en verwachtingen tijdens elke fase van de interactie?
- Wat zijn mogelijke verbeterpunten of suggesties die je hebt om het succes te verhogen?
- Hoe zie je je eigen…
    - Bewustwording
    - Interesse (Kennis, overweging, waarderen)
    - Desire (Voorkeur, overtuiging)
    - Action (Eerste gebruik, tevredenheid, aanbeveling)

Follow-up question per phase, depending on answers of previous questions

- Awareness:
    - Welke bronnen of kanalen hebben bijgedragen aan jouw bewustwording van circulaire ontwerpprincipes?
    - Wat waren jouw eerste gedachten of reacties toen je voor het eerst hoorde over circulair ontwerpen?
    - Hoe belangrijk vind je circulair ontwerpen in vergelijking met traditionele ontwerpmethoden?
- Knowledge:
    - Wat weet je momenteel over circulair ontwerpen en de principes die ermee gepaard gaan?
    - Heb je training gevolgd over circulair ontwerpen?
    - Wat zijn volgens jou de belangrijkste voordelen van circulair ontwerpen?
    - Zijn er specifieke uitdagingen of obstakels die je ziet bij het implementeren van circulaire ontwerpprincipes?
- Interest:
    - Hoe groot is jouw interesse in het toepassen van circulaire ontwerpprincipes in jouw werk?
    - Welke factoren motiveren je om circulaire ontwerpprincipes toe te passen?

    - Heb je interesse in het leren over specifieke aspecten van circulair ontwerpen, zoals materiaalhergebruik, levensduurverlenging of producthergebruik?
- Consideration:
    - Heb je weleens de haalbaarheid en toepasbaarheid van circulaire ontwerpprincipes geëvalueerd voor jouw projecten?
    - Welke criteria houd je in gedachten bij het overwegen van circulair ontwerpen als een mogelijke optie voor jouw projecten?
    - Hoe belangrijk is duurzaamheid voor je bij het nemen van beslissingen over ontwerpbenaderingen?
- Preference:
    - Heb je een voorkeur voor circulair ontwerpen boven traditionele lineaire ontwerpmethodes? Waarom wel of niet?
    - Wat zijn volgens jou de belangrijkste voordelen van circulair ontwerpen ten opzichte van traditionele ontwerpprincipes?
    - Zijn er specifieke aspecten van circulair ontwerpen die je aanspreken of die je als waardevol beschouwt voor jouw werk?
- Conviction:
    - Hoe overtuigd ben je van de effectiviteit en waarde van circulaire ontwerpprincipes voor jouw projecten?
    - Heb je anderen binnen je afdeling kunnen overtuigen van de voordelen en mogelijke positieve resultaten van het implementeren van circulaire ontwerpprincipes?
    - Welke bewijzen of case studies zouden je verder kunnen overtuigen van de waarde van circulair ontwerpen voor jouw werk?
- Action:
    - Ben je momenteel actief bezig met het toepassen van circulaire ontwerpprincipes in jouw projecten? Zo ja, op welke manier?
    - Heb je concrete stappen ondernomen om circulaire ontwerpprincipes te integreren in jouw ontwerpen en projecten?
    - Zijn er specifieke uitdagingen of obstakels die je bent tegengekomen bij het implementeren van circulaire ontwerpprincipes? Zo ja, welke?
- Satisfaction:
    - Hoe tevreden ben je met de resultaten van jouw circulaire ontwerpkeuzes?

    - Heb je positieve resultaten gezien, zoals minder gebouwen, lagere kosten, tijdsbesparing o.i.d. als gevolg van het toepassen van circulaire ontwerpprincipes?
- Advocacy:
    - Zou je circulair ontwerpen aanbevelen aan collega's of concullega's van de waterschappen? Waarom wel of niet?
    - Zou je je ervaring delen om anderen aan te moedigen om circulaire ontwerpprincipes toe te passen en te omarmen? Zo ja, op welke manier?

Interventions with COM-B model

Questions

- Wat zou je helpen om meer circulair te ontwerpen? Wat heb jij nodig?
- Hoe zou je circulair ontwerpen stimuleren?
- Welke interventie zou je het aangenaam vinden, en welke staat je tegen?
- Wat stel je je bij deze interventie voor?

Explanation of COM-B and TDF

1. Explanation of COM-B framework, TDF and intervention functions naming interventions as inspiration, with the side note that the model is intended for inspiration, to give participants words for interventions.

Questions (repeated after COM-B and TDF explanation)

- Wat zou je helpen om meer circulair te ontwerpen? Wat heb jij nodig?
- Hoe zou je circulair ontwerpen stimuleren?
- Welke interventie zou je het aangenaam vinden, en welke staat je tegen?
- Wat stel je je bij deze interventie voor?

Closing remarks

Dit waren mijn vragen, maar ik ben erg benieuwd of er punten zijn die je had verwacht die ik zou vragen, of dat er goede gedachten of ideeën zijn die je nog wil delen.

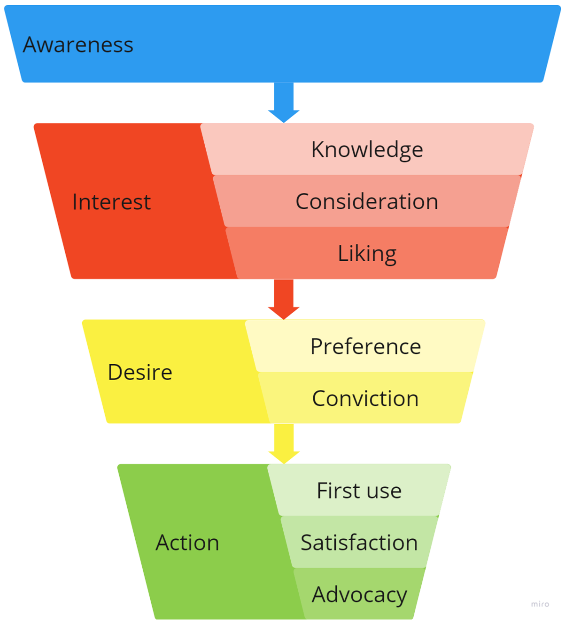
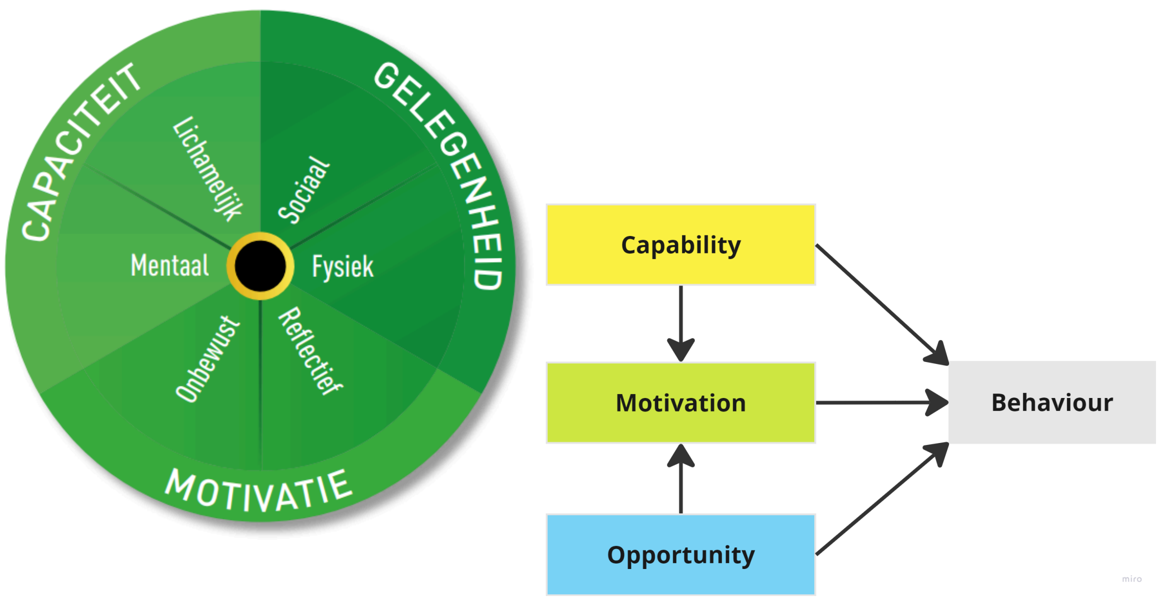


Figure aiding the explanation of adapted AIDA model



Figures aiding the explanation of COM-B framework

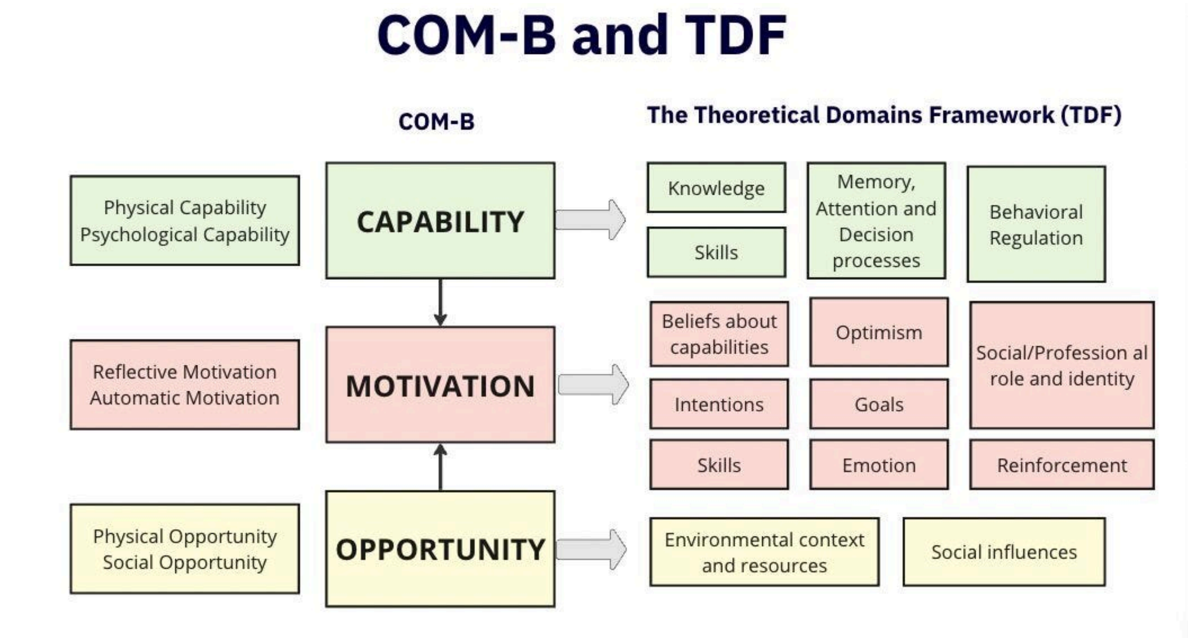
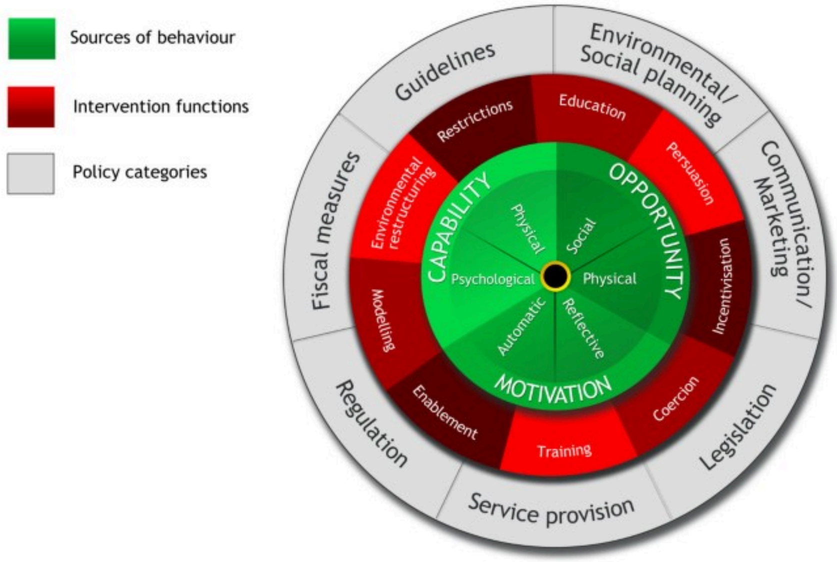


Figure aiding the explanation of Theoretical Domains Framework



Figures aiding the inspiration of intervention

Appendix B. Actors

This appendix expands on the information presented in the master thesis, and provides more detail on the various actors involved in wastewater treatment projects at Royal HaskoningDHV (RHDHV) and the Client Water Authority. It outlines their responsibilities, goals, and specific tasks related to circular design of wastewater treatment plants to ensure a clear understanding of each actor's role in the project, based on the interviews conducted at the Royal HaskoningDHV Wastewater department. Responsibilities, tasks and activities unrelated to wastewater facilities are out of scope for this appendix.

Actor Royal HaskoningDHV Wastewater department

Source: D1–D8, D9, D10, D15–D22, informal conversations and observations

Royal HaskoningDHV Wastewater department consists of the actors Management, Project managers, Technical managers, Lead engineers, and Engineers, which consist of Process technologists, Hydraulic engineers, Civil engineer, Electrical engineer and Mechanical engineers. Process technologists are found to be slightly distinct and further away from other engineers due to their early engagement in the process, and are therefore often referred to as technologists instead of engineers. The terminology surrounding Project and Technical managers and lead engineers is somewhat fluid. In some cases these are three different roles and people, in smaller projects this is combined into a single person. Teams vary in size and composition depending on the type of project.

Management runs the wastewater department and thus decides the long-term tactical strategy, which is to be frontrunners in sustainable design. The main ambition is to make a profit and keep the department running smoothly

Project managers are ultimately responsible for successful and qualitative implementation of the project within deadlines and budget; lead the Project team to smooth collaboration and maintains contact with the customer. They are tasked with planning and leading consistently; determine the scope, problem and approach and mindset of the project and check whether the customers preferences match to the possibilities in the design. They verify whether the design meets project requirements, schedule and budget and handle potential discussions and division of work and tasks.

Technical managers are responsible for the content and quality of the design by ensuring that the work of all disciplines connect on each other and that the design is still correct when all the work of the different disciplines comes together. They lead the design team and engineers, and lead the general design. They discuss the substantive options with the client and the project manager.
The role of a lead engineer is either a technical manager function, or a senior engineer engaged with the project having a substantial role. They are tasked with the responsibility to concretise the design ideas to a point where it can be put into a 3D-model, by merging principles into a single design. Furthermore, they are mentioned to inspect the wastewater facilities to be renovated or expanded.

Engineers design the project design in early stages or in detail towards the final design. Process technologists advise customers on system choices and on technologies which suits their needs and how the technologies they use can be optimised. They determine e.g. the volume of the pumps and conduct variant studies on the wastewater facilities. Hydraulic advisors calculate the hydraulic aspects, being e.g. the size of the pipes and tanks. They submit, request and check data and report it to the technical manager. Performing hydraulic calculations is a junior position in itself, but is also done by participants who are civil, mechanical, or process technology engineers. When the pump volumes etc. are defined, the mechanical engineers design and develop the mechanical installation components such as pumps, and draw the Process Flow diagrams in P&ID. They create 3D models of the mechanical components and describe the parts in number, properties (e.g. heads, capacities) and operation. The electrical engineer creates a design for the electrical supply and control, and determines everything that has to do with power supply, electrical and control. Up until the indication of location and space for the electrical enclosure and designing the instrumentation.

Actor Client Water authority

Source: RHDHV interviews D2–D5, D7–D9, D11–D22

The **water authorities**, or water boards, consist of several relevant actors, which are management, the project team (a.k.a. Department Design and Realisation) and maintenance people (a.k.a. Department Administration and Maintenance) and are referred to within RHDHV as 'the client'.

Management are tasked with the overall responsibility of the functioning of the sewage water treatment, managing dikes and water protection abd regulating water levels with e.g. pumping stations and locks. They committed themselves to organising the implementation of sustainability and circularity goals and energy efficiency; ensuring financial health, and aim to standardise across projects.

The Project Team focuses on the successful design and realisation of projects within the stipulated timeline and budget. They aim to meet the needs of both Management and Maintenance, ensuring quick and cost-effective construction with well-coordinated project phases.

Maintenance, a.k.a. the operational manager or the Deparmtent of Administration and Maintenance, maintain and operate wastewater treatment facilities, fix malfunctions, and selectively participate in design team meetings. Their goals include ensuring safe operation and minimising malfunctions and therefore prefer new and reliable materials, ensuring accessible installations, and minimising maintenance efforts. When re-use is applied, maintenance is the actor who is negatively impacted, as they have to must maintain it and probably fix when the re-used part breaks down earlier than a new part would. Therefore it is mentioned that they have no desire to properly fix a re-used part if it is not properly designed to their liking. In the design process, department maintenance often only join the DO phase when the abstract choices have been made concrete, but when it is also too late to change the substantial choices. In some cases, the main operational manager of the treatment plant is part of the water authorities project team to deliver the wishes (and sometimes requirements). Either way, they have a a strong influence on the project team, even though it is not their main task.

Actor Contractor and Supplier

Source: RHDHV interviews D7, D13–D15, D17, D19, D20)

The **supplier** is mentioned in the interviews to be available for the supply of parts, and is also happy to offer a popular range of products, as long as it remains profitable. Suppliers are required by law to provide the certification and data on the production of materials and are voluntarily required to provide a materials passport.

The **contractor** is hired by the water authority to implement the design created by firms like RHDHV. They are responsible for translating the final design into a detailed execution plan and procuring the necessary products. They choose the products and materials based on the specifications outlined in the final design.

Project involvement

The process as described in the master thesis is a standard process, but each process differs from the example standard process in its own details, size, variation, difficulty and context. As an indication of the involvement of each actor in each phase of a standard traditional process where RHDHV is tasked with the design, Water authorities for overseeing the implementation by the Water authorities and the constructor involved since the Implementation Tender (Bron: Interviews D1–D22)

Table 1: Actors involved in traditional design and realisation process

Phases / Actors	Quote	Systems choice	Preliminary design	Final Design	Tender	Implementa tion design
RHDHV						
Management	x					
Project managers	x	x	x	x	x	
Technical managers		x	x	x	x	
Lead engineer		x	x	x	x	
Proces technoloog		x				
Hydraulic advisor		x				
Civil Engineer			x	x	x	
Electrical engineer			x	x	x	
Mechanical engineer			x	x	x	
Client						
Management	x	x			x	
Project team	x	x	x	x	x	x
Maintenance				x	x	x
Supplier					x	x
Contractor						x

Appendix C. Transcriptions

Due to signed statements as approved by the Human Research Ethics committee and Graduation agreements, the transcriptions and their summaries are not available for public access.

The transcribed interviews have been sent to the participants after transcription and — if necessary— have been clarified. All participants approved the use of the transcriptions in this report.

Choices in transcription: Filler words, such as "ehms" and "uhms," have been removed to make the text more readable, as well as meaningless half-started sentences. For example, “Circularity is, ehm, ..., circularity encompasses [..]” is written as “Circularity encompasses [...]”. This non-verbal data has not been included in the transcription because it was not fully capturable on paper and was not the aim. Additionally, it makes the transcriptions more readable and the analysis clearer.

Appendix D. Codebooks

Appendix D presents the codebooks used for qualitative analysis, detailing the categories and codes derived from the interviews. It includes both explorative and targeted coding frameworks, which help link the empirical data directly to the theoretical constructs used in the study.

Choices in coding

Some participants mixed up sustainability and energy efficiency with circularity. When discussions veered away from circularity and focused solely on sustainability or energy usage, I did not label the mentioned barriers. However, comments about energy usage that were relevant to circularity were still used. This way, I kept the analysis focused on circularity without confusing it with energy efficiency issues and the quantitative results free of non-circular issues.

In some cases, a single code was applied to a large section of text. I chose to do this to capture the full context and meaning of the participants' statements. While this made the quotations longer and more complex to read, it ensured that the data's richness and depth were preserved.

For instance, in document D6, some interviewees switched between talking about their own experiences and analysing broader problems. When coding, I only focused on his personal experiences and how he performed his roles. This approach helped to capture individual opinions and experiences rather than general thoughts. However, any interesting, relevant, or new general thought or pattern was included in the results section.

Codebook Explorative

During the first round of coding, I focused on coding with an open explorative mindset, with keeping in mind that I wanted to have all facilitators (factors that help the process move forward) and barriers (obstacles that hinder progress) labelled, as well as anything that described a current practice or perception in circular design. If a factor clearly acted as both a barrier and a facilitator, I marked it as both.

As the codebook began to take shape, distinctions within a label became clearer, leading me to split some labels, while merging others that turned out to be more related than initially expected. After coding all the interviews, I reviewed them again using the finalised codebook. The final version of the codebook is presented in Table 1.

Codes concerning Actors

Code	Description	Inclusion criteria
Aannemer	Refers to contractors involved in the project, discussing their roles or actions.	Mention of contractors' specific tasks, decisions, or involvement in the project.
Actor	Involves any key player in the project, focusing on their role or impact.	References to specific actions, responsibilities, or influence of individuals or groups on the project.
Engineer	Concerns engineering roles and responsibilities within the project.	Discussions specific to engineering tasks, challenges, or technical details.
Junior	Pertains to less experienced team members, often in reference to their learning or tasks.	Mentions of junior staff involvement, learning situations, or task assignments.
Klant	Focuses on client interactions, expectations, and feedback.	Direct mentions of client requirements, feedback sessions, and their impact on project outcomes.
Klant: Beheer en Onderhoud	Specifically addresses the client's maintenance and operations concerns.	Mentions of maintenance and operations as discussed or influenced by the client.
Klant: Management	Involves discussions about the client's management team and their decisions.	Specific mentions of client management actions or decisions impacting the project.
Klant: Project team	References the client's project team members and their roles.	Specific mentions of the roles or actions of client project team members.
Lead engineer	Focuses on the role and contributions of lead engineers in the project.	Discussions about tasks, decisions, or leadership provided by lead engineers.
Markt	Addresses market conditions or influences on the project.	Specific references to market trends, demands, or conditions affecting the project.
Senior	Related to senior staff members and their roles or influence within the project.	Mentions of senior staff responsibilities, decision-making, or mentorship.
Technisch manager	Relates to the technical manager and their specific responsibilities.	Discussions on the roles, decisions, or leadership impact of technical managers within the project.
Hydraulica	Involves technical challenges or constraints related to hydraulic systems that impact project implementation.	Specific references to hydraulic issues that prevent or complicate the adoption of sustainable or circular solutions.
Klant (Actor)	Relates to the water authority as a whole, referred to as 'the client'.	Direct mentions of client-driven constraints or demands that hinder the implementation of circular or sustainable practices.

Codes concerning Barriers

Code	Description	Inclusion criteria
Commerciële organisatie	Refers to issues arising from the commercial priorities or profit-driven decisions of the organization.	Discussions about decisions or practices primarily driven by profit motives that may conflict with circular or sustainable goals.
Al goed bezig op andere milieu-punten	Focuses on the perception that sufficient environmental efforts are already in place, potentially limiting further actions.	Discussions that justify limited action on new environmental initiatives because existing ones are deemed sufficient.
Andere zaken belangrijker	Indicates priority is given to other matters over environmental or circular initiatives.	Statements prioritizing other business, economic, or operational concerns over environmental considerations.
Beheerders tevredenheid en gemak	Refers to prioritizing the ease and satisfaction of managers or operators, which can impede more ambitious changes.	Instances where decisions are made primarily based on the convenience or satisfaction of operational staff.
Collegas zijn er niet mee bezig	Highlights a lack of engagement or interest in environmental or circular practices among colleagues.	Comments about colleagues not being involved or interested in implementing or discussing such practices.
Commercieel belang niet-circulair Nereda	Specific reference to the Nereda technology or process being non-circular for commercial reasons.	Discussions about the commercial benefits of Nereda technology that prevent adoption of more circular alternatives.
Complexe afweging	Describes scenarios where decision-making is complicated by multiple factors, often hindering straightforward actions.	Situations where complex trade-offs between costs, benefits, and environmental impacts are discussed.
Conservatisme en routine	Indicates a barrier due to traditional thinking or established routines.	Mentions of resistance to change because of entrenched habits or conservative attitudes.
Drukte	Refers to high levels of activity or busyness that prevent focus on circular initiatives.	Statements that link a high workload or pace to a lack of action on new initiatives.
Eensgezindheid	Points to a consensus or uniformity in opinion, which can be a barrier if it supports non-circular practices.	Situations where a uniform agreement among stakeholders supports status quo or non-circular options.
Ergens anders grotere winst	Focus on greater profits or benefits in other areas, drawing focus away from circular initiatives.	Discussions emphasizing more profitable ventures elsewhere as a reason for not pursuing circular options.
Esthetisch	Aesthetic concerns that conflict with or prevent the adoption of circular or sustainable solutions.	Situations where aesthetic preferences impact the selection of materials or designs against circular options.
Fasering	Issues related to the phasing of project components that can delay or disrupt the implementation of circular practices.	Discussions on project timing or sequencing that impact the adoption of circular methods.
Geen drive voor C uitzoeken	Lack of motivation or interest in exploring circular options ('C' likely stands for circularity).	Statements explicitly mentioning a lack of desire to explore or implement circular practices.

Geen herbruikbare onderdelen beschikbaar	The unavailability of reusable components, which can be a practical barrier to implementing circular practices.	Mention of a lack of reusable parts or components as a reason for not adopting circular solutions.
Geen klant contact	Lack of direct interaction with clients that could influence or promote circular practices.	Instances where the absence of client communication is noted as a barrier to advancing circular initiatives.
Geen verwachting willen stellen aan mensen die het niet kunnen	Reluctance to set expectations for individuals perceived as incapable of meeting them.	Discussions about not setting ambitious environmental goals due to perceived limitations of involved parties.
Gegevens voor MKI	Refers to the specific data needed for 'Milieukostenindicator' (Environmental Cost Indicator) calculations, suggesting challenges in obtaining it.	Discussions about difficulties or barriers in obtaining necessary data for environmental impact assessments.
Gemakkelijk tot resultaat komen	Preferring easier or more straightforward paths to completion, potentially at the expense of more sustainable options.	Instances where the ease of implementation is prioritised over more sustainable but complex alternatives.
Handvaten	Refers to tools or guidance needed to implement practices, with the barrier being their absence or inadequacy.	Discussions indicating a lack of sufficient tools or guidelines to implement circular practices.
Irritatie over poppenkast	Irritation or frustration with what is perceived as unnecessary or superficial measures.	Statements expressing frustration with actions seen as merely symbolic or not genuine.
Klant	Issues arising specifically from client demands or lack of support that hinder circular practices.	Discussions where client requirements or lack of interest pose barriers to implementing circular methods.
Kost moeite	The effort required is seen as a barrier to implementing new practices.	Statements that highlight the significant effort needed to implement changes as a deterrent.
Kost tijd	Time required to implement changes or new practices acts as a barrier.	Discussions emphasising time constraints as a reason for not pursuing new or more sustainable practices.
Kosten en Klant budget	Financial constraints, whether related to overall costs or specific client budgets, acting as barriers.	Mentions of budget limitations or high costs as reasons for not adopting sustainable or circular practices.
MKI berekening tool	The tool used for environmental cost calculations may present usability or accessibility issues.	Discussion of difficulties using or accessing the MKI calculation tool, impacting environmental assessments.
Negativiteit collega's/markt	Negative attitudes from colleagues or market perceptions that hinder progressive practices.	Statements about negative sentiments in the workplace or market affecting the adoption of new practices.
Niet diens taak of rol	Perception that it is not someone's job or role to engage in certain practices, used as a justification for inaction.	Assertions that environmental or circular tasks fall outside the responsibilities of the individual or group.
Niet doorvragen of bij stil staan	Failing to inquire deeply or consider important aspects, leading to superficial or incomplete implementations.	Lack of critical questioning or consideration noted as leading to ineffective or shallow practices.

Nieuw idee heeft minder zekerheden	New ideas seen as less certain or risky, deterring their adoption.	Discussions focusing on the uncertainties or risks associated with new concepts, discouraging their use.
Onduidelijkheid, onbekend, mist kennis	Uncertainty or lack of knowledge acting as a barrier to implementing new practices.	Mentions of uncertainty, unfamiliarity, or lack of knowledge as reasons for not pursuing sustainable options.
Ongewenste verplichting	Obligations that are perceived as undesirable or imposed, hindering engagement.	Discussions of obligations felt to be forced or unwelcome, affecting motivation to implement new practices.
Onwennig	Describes discomfort or unfamiliarity with new practices, acting as a psychological barrier.	Use of the term to describe reluctance or discomfort with new methods or technologies.
Pessismisme over uitvoerbaarheid en mogelijkheden	Pessimism about the feasibility or potential of new practices.	Expressions of doubt or pessimism regarding the practical implementation of new or innovative practices.
Pionieersgroep mislukt	References to a failure of a pioneering group or initiative, used as a cautionary tale against similar efforts.	Mention of previous failures in innovative groups as a deterrent to new attempts.
Realisatiehobbel	Describes significant challenges or 'humps' to overcome in the realisation of projects, especially new initiatives.	Discussion of major obstacles encountered in the implementation phase that hinder progress.
RHDHV ambitie onduidelijk	Uncertainty about the company's (RHDHV's) goals or commitments, particularly regarding environmental practices.	Statements indicating confusion or lack of clarity about RHDHV's environmental ambitions or strategies.
Ruimte m	Likely refers to physical or metaphorical space constraints impacting the implementation of practices.	Discussions about limited space or capacity as barriers to adopting new practices.
Scepsis over toegevoegde circulariteit/nut, geen geloof in, kritisch op	Scepticism about the benefits or practicality of circular practices.	Negative view, sceptical or critical views on the efficacy or usefulness of circular methods.
Strakke tijdsplanning project	Strict or tight project timelines that limit the scope for implementing new or untested practices.	Discussions about tight schedules as reasons for not incorporating innovative or time-consuming practices.
Te laat in proces C meenemen	Incorporating circular practices too late in the project process to be effectively implemented.	Instances where circular practices are considered only at advanced stages, limiting their integration.
Te zweverig en onrealistisch ideeën	Ideas perceived as too abstract or unrealistic, acting as barriers to practical implementation.	Descriptions of ideas as impractical or overly theoretical, preventing their adoption.
Technische functionele eisen - kwaliteit	Technical and functional requirements focused on quality, which may conflict with innovative practices.	Discussions that prioritise traditional quality standards potentially at odds with innovative approaches.
Twijfel over mogelijkheden	Doubt about the capabilities or possibilities of new practices or technologies.	Expressions of doubt or passive skepticism about the effectiveness or feasibility of new practices.

Veel werk, weinig mensen in de markt	High workload and a limited number of professionals available in the market.	Discussions about the scarcity of skilled labor or high workload as barriers to project progress.
Vergeten C te doen	Forgetting to implement circular practices during project execution.	Instances where circular practices are overlooked or omitted during planning or execution.
Verstorend voor werkproces	New practices that disrupt established work processes, seen as a barrier.	Discussions about how new practices interfere with or disrupt current workflows.
Woord C misleidend	The term 'circular' (C) is seen as misleading, possibly creating confusion or misaligned expectations.	Use of the term 'circular' in ways that lead to misunderstandings or scepticism about its meaning.

Labels 'Twijfel over mogelijkheden' and 'Scepsis over toegevoegde circulariteit/nut, geen geloof in, kritisch op' differ in the tone of the participants. The first indicates a doubt on the existence of circular alternatives, with a neutral or positive tone, and the second is distrust concerning the alternatives with a negative tone.

Codes concerning Facilitators

Code	Description	Inclusion criteria
(Beste) alternatief zoeken	Identifying the best alternative that aligns with circular design principles.	Discussions about evaluating different options to find the most sustainable and efficient solution.
Beheer en Onderhoud meenemen	Including maintenance and operations teams in the design process to ensure practicality and ease of long-term use.	References to involving maintenance staff in early design discussions.
Belonen	Providing rewards for implementing circular design practices to encourage adoption.	Mentions of incentives or rewards given for sustainable practices.
Berispen bij niks C doen	Implementing penalties or reprimands for not adopting circular design practices.	References to consequences or penalties for failing to consider circular options.
Bespreken met klant	Discussing circular design possibilities with the client to align on sustainable goals.	Instances where circular design options are explicitly discussed with clients.
Bij start overleg	Incorporating circular design discussions at the start of project meetings.	Mention of early-stage meetings that prioritise circular design considerations.
Bij systeemkeuze	Considering circularity when choosing systems and components.	References to evaluating systems based on their sustainability and reusability.
Brede kennis (van diverse projecten)	Leveraging extensive knowledge from various projects to enhance circular design.	Examples of applying lessons learned from diverse projects to new circular design efforts.
Budget van klant	Utilising client budgets to support circular design initiatives.	Discussions on how client budgets are allocated to support sustainable practices.

C laten meeliften op andere drijfveer	Integrating circular design as a secondary benefit of other primary project drivers.	Instances where circular design is achieved as a byproduct of other project goals.
Checklist van mogelijkheden	Using checklists to identify and implement circular design opportunities.	References to specific checklists used to guide sustainable design choices.
Circulariteit in MCA	Including circularity criteria in multi-criteria analysis (MCA) for decision-making.	Examples of MCA processes that incorporate sustainability metrics.
Circulariteit, MKI kunnen berekenen	Capability to calculate the Environmental Cost Indicator (MKI) to assess circularity.	Mentions of using MKI calculations to measure environmental impacts.
Controlevragen	Using control questions to ensure circular design principles are applied.	Instances of applying specific questions to verify the implementation of circular design.
Daling werkdruk door minder projecten of meer collegas	Reducing workload through fewer projects or increased staffing to focus on circular design.	Discussions about managing workload to prioritise sustainable practices.
Doelstellingen	Setting clear goals for achieving circular design in projects.	Examples of specific, measurable goals related to circular design.
Durven	Encouraging risk-taking and innovative thinking to adopt circular design.	Mentions of bold decisions or innovative approaches to incorporate sustainability.
Elkaar aansporen	Promoting peer encouragement to adopt circular design practices.	Instances where team members motivate each other to implement sustainable solutions.
Gemakkelijk te doen	Ensuring that circular design practices are straightforward and easy to implement.	Discussions about simplifying processes to make sustainable practices more accessible.
Herhalen	Reinforcing circular design principles through repetition and ongoing communication.	Examples of regular reminders and continuous emphasis on sustainability.
Hot topic	Highlighting circular design as a current and relevant issue.	References to the increasing importance and visibility of circular design in the industry.
Iemand die bevraagt, aanzet, checkt op circulariteit	Having a dedicated person to question, initiate, and check circular design practices.	Instances where a specific role or person is responsible for promoting and ensuring sustainability.
Iemand die tips geeft over circulariteit	Providing practical tips and advice on implementing circular design.	Examples of sharing best practices and actionable suggestions for sustainability.
In offerte meenemen	Including circular design considerations in project proposals and bids.	Mentions of sustainability criteria in initial project documents and proposals.
Info toegankelijk	Making information about circular design easily accessible to all team members.	References to resources and information being readily available for sustainable practices.
Initiatieven	Encouraging and supporting initiatives that promote circular design.	Examples of new projects or actions specifically aimed at enhancing sustainability.
Interesse groeien door ermee bezig	Fostering interest in circular design through active engagement and practice.	Instances where hands-on experience and involvement increase enthusiasm for

zijn		sustainability.
Interesse hebben erin	Demonstrating genuine interest in and commitment to circular design principles.	Mentions of personal or professional enthusiasm for adopting sustainable practices.
Inzicht in mogelijkheden	Providing clear understanding and visibility of circular design opportunities.	Examples of identifying and communicating various options for implementing sustainability.
Kennis op- en uitzoeken	Actively seeking and acquiring knowledge about circular design practices.	References to research, learning, and gaining expertise in sustainability.
Kennis van collega's	Leveraging the knowledge and experience of colleagues to enhance circular design.	Examples of knowledge sharing and collaboration to promote sustainability.
Klant pushen, overtuigen en bevragen	Actively encouraging and persuading clients to adopt circular design principles.	Discussions about efforts to convince clients of the benefits and importance of sustainability.
Klant speelt marktplaats	Clients acting as facilitators by demanding or prioritizing sustainable practices.	Instances where client requirements drive the adoption of circular design.
Klant vraagt ernaar, wenst het, geeft prio, komt met ideeën	Clients expressing explicit demand and preference for circular design.	Mentions of clients initiating or strongly supporting sustainable practices.
Knokken voor C.	Actively fighting for and advocating circular design principles.	Examples of strong advocacy and persistent efforts to implement sustainability.
Learning on the Job, toepassen	Implementing circular design principles through practical, on-the-job learning.	Instances where hands-on experience is used to apply and improve sustainability practices.
maak het leuk en niet moeilijk	Making circular design engaging and straightforward to encourage adoption.	Examples of simplifying processes and making sustainability enjoyable.
Maak het praktisch, concreet	Focusing on practical, tangible actions to implement circular design.	Discussions about actionable steps and concrete measures for sustainability.
Meenemen bij fase van materiaalkeuzes	Meenemen bij fase van materiaalkeuzes	Incorporating circular principles during the material selection phase.
Meenemen bij VO en DO	Meenemen bij VO en DO	Including circular design considerations in the Preliminary and Final Design phases.
Minderen door te bevragen of eisen, bouw of product wel nodig is	Minderen door te bevragen of eisen, bouw of product wel nodig is	Reducing unnecessary elements by questioning their necessity and promoting sustainability.
MKI data hebben, info van leveranciers	MKI data hebben, info van leveranciers	Having access to Environmental Cost Indicator (MKI) data and information from suppliers.
Nut ervan	Nut ervan	Recognizing the importance and benefits of circular design.

Onderdeel van Op te leveren documenten	Onderdeel van Op te leveren documenten	Including circular design elements in the final project deliverables.
Optimisme en Enthousiasme	Optimisme en Enthousiasme	Fostering a positive and enthusiastic attitude towards circular design.
Plezier in C, werk leuk vinden	Plezier in C, werk leuk vinden	Enjoying the process of implementing circular design and finding the work fulfilling.
Ruimte geven voor C werken	Ruimte geven voor C werken	Providing the necessary space and resources to focus on circular design work.
Scan voor herbruikbare onderdelen	Scan voor herbruikbare onderdelen	Conducting scans to identify reusable components and materials.
Sparren met	Sparren met	Engaging in brainstorming sessions to develop circular design ideas.
Standaard onderdeel van proces	Standaard onderdeel van proces	Making circular design a standard part of the project process.
Standaardisatie	Standaardisatie	Standardising circular design practices across projects.
Tijd maken	Tijd maken	Allocating specific time for planning and implementing circular design.
Tijdswinst in proces	Tijdswinst in proces	Achieving time efficiency through the adoption of circular design practices.
Training, voorlichting	Training, voorlichting	Providing training and education on circular design principles.
Vakgerelateerde externe bronnen (beurzen, vakbladen)	Vakgerelateerde externe bronnen (beurzen, vakbladen)	Using industry-related external sources like trade fairs and journals to stay updated on circular design.
Voorbeelden	Voorbeelden	Providing concrete examples of successful circular design implementations.
Vroeg in proces	Vroeg in proces	Incorporating circular design considerations early in the project lifecycle.
Waardering	Waardering	Valuing and recognizing efforts towards implementing circular design.
Weten waar gemakkelijk of veel winst te behalen valt	Weten waar gemakkelijk of veel winst te behalen valt	Identifying areas with the highest potential for significant sustainability gains.
Wetgeving	Wetgeving	Leveraging laws and regulations that support circular design implementation.

Codes concerning Requirements

Code	Description	Inclusion criteria

Energiezuinig	Involves requirements aimed at enhancing energy efficiency as part of circular design practices.	Explicit connections between energy-saving measures and circular design strategies.
Ervaring	Focuses on the importance of practical experience in applying circular design principles in engineering.	Mentions of situations where past experience with similar projects influences decisions or practices.
Functionele eisen	Relates to how functional requirements must support or enable the application of circular design elements.	Specifications that integrate functional performance with sustainability or reusability aspects.
Gemak	Prioritises the ease of integration and application of circular design practices within existing workflows.	References to design choices or practices that simplify the adoption of circular principles in engineering.
Kennis	Pertains to the specific knowledge necessary to understand and implement circular design effectively.	Discussions detailing the technical or specialised knowledge required for circular design in wastewater projects.
Klanteisen	Details client-imposed requirements that either support or limit the implementation of circular design practices.	Client requirements that specifically call for sustainable, recyclable, or reusable materials and processes.
Technische eisen	Concerns the technical specifications that must be met to facilitate circular design in wastewater projects.	Technical standards that encourage or mandate the use of circular materials and methods.

Codes concerning Current Circular Practice and Options

Code	Description	Inclusion criteria
Conservering	Practices aimed at preserving resources and extending the life cycle of materials.	Specific mentions of techniques used to conserve resources in project designs.
Cradle Core certificaat	Certification indicating that products are designed according to Cradle to Cradle principles.	References to projects or materials that have achieved or are pursuing this certification.
Dubocalc	A tool used for calculating the environmental impact of construction materials and techniques.	Usage of Dubocalc in evaluating or optimizing project materials for environmental impact.
Duurzaamheidssessies	Sessions or workshops focused on enhancing sustainability within project teams by e.g. brainstorming	Instances where teams engage in meetings specifically aimed at discussing and improving sustainability or circularity.
Herbestemming gebouw	Repurposing existing buildings for new uses to minimise waste and reduce the need for new materials.	Discussions about projects where existing buildings are adapted for new purposes.
Herbestemming tank	The adaptation of tanks for different purposes or applications within the same infrastructure.	Instances where tanks are reused or repurposed rather than replaced.
Herbruikbare wand-elementen	Design and use of wall elements that can be easily reused or reconfigured.	Specific mentions of designing with reusable wall components in infrastructure projects.
Hergebruik is normaal	The normalization of reuse practices within the project or organization.	Discussions emphasizing reuse as a standard practice in project management and design.

Houten leidingbrug	Using wood for piping bridges instead of less sustainable materials, promoting renewable resources.	Use of wooden structures in piping applications noted for their sustainability.
Kijken wat er in de markt is en toegepast kan worden	Exploring market-available sustainable solutions and integrating them into projects.	Active research into and application of the latest market innovations in sustainability for project designs.
Minder reserve-capaciteit	Reducing overcapacity in systems to optimize resource use and efficiency.	Planning and design discussions where system capacities are closely aligned with actual needs.
Objectenboom, ambtitieweb, GWW	Utilizing specific frameworks like the Object Tree and Ambition Web in Civil, Road, and Hydraulic Engineering.	Application of these frameworks to systematically incorporate sustainability goals into projects.
PFAS kunststof afsluiters	Using PFAS-free plastic materials for valves and other components to avoid environmental contamination.	Selection of non-PFAS plastics in project specifications for environmental protection.
Pomp met hijsbanden ipv stalen ketting	Choosing hoisting straps instead of steel chains for pump operations to reduce metal use and increase safety.	Specific instances where alternative materials are used in pump operations to enhance sustainability.
Recyclen van materialen	The process of repurposing waste or used materials into new products or applications.	Examples of recycling initiatives within projects to minimize waste and reuse materials.
Ronde tank	The use of circular tanks to optimize space and materials, enhancing both aesthetic and functional aspects.	Design choices that favor round tanks for their efficiency and reduced material usage.
Staal vs kunststof leidingen	Choosing between steel and plastic piping based on sustainability criteria and project requirements.	Discussions weighing the benefits and drawbacks of steel versus plastic piping in terms of sustainability.
Modulair Verdygo	Adoption of a modular construction approach that allows for flexibility, scalability, and sustainability in design.	Projects that implement modular design principles to facilitate future adaptations and reduce waste.
Nieuwe standaard / Standaardisatie	Establishing and implementing new (mainly electrical) standards that specifically incorporate circular design principles into routine practices and standardised objects	Discussions or actions focused on developing and applying new standards that explicitly include sustainability and reuse as key components in project standards.

Other codes

Code	Description	Inclusion criteria
Beprijzen milieu-effecten	Focusing on the economic valuation of environmental impacts within project decision-making.	Instances where environmental cost calculations are integrated into the budget.
Betrokkenheid bij besluitvorming	Engaging diverse stakeholders in the decision-making process to enhance project outcomes and sustainability.	Descriptions of inclusive decision-making processes that consider a wide range of stakeholder inputs.

Bevragen	Actively questioning and challenging current practices to explore more sustainable options.	Instances of stakeholders or team members critically evaluating existing methods for potential improvements.
Circulariteit definitie	Defining what circularity means within the context of wastewater engineering projects.	Discussions that aim to establish a clear and operational definition of circularity applicable to project settings.
Circulariteit ideeën	Generating and discussing innovative ideas to promote circularity in projects.	Brainstorming quotes where new circular design ideas and options are proposed and discussed.
Circulariteit vs kwaliteit	Balancing the relationship between maintaining quality and enhancing circularity in project outcomes.	Evaluations that consider both the sustainability and the quality of project outputs.
Demontabel	Designing systems and components that can be easily disassembled for reuse or recycling.	Projects that include specifications for demountable features to facilitate future reuse.
Diversiteit binnen waterschappen	Reviewing the variety of water authorities, in either context, organisation or ambition.	Quotes where diversity or comparison between water authorities is present.
Duurzaamheid	Committing to sustainability as a core principle in all project phases and operations.	Instances where sustainability is integrated as a key component in project planning and execution.
Duurzaamheidsco ördinator	Designating an individual responsible for overseeing and promoting sustainability within projects.	Mention of a specific role or individual tasked with ensuring sustainability goals are met.
Eensgezindheid	Achieving, or lack thereof, and the role of consensus among stakeholders about the importance and methods for implementing circular practices.	Descriptions of (non-)unanimous agreement or collaborative decision-making on sustainability approaches.
Functie, werkzaamheden en werkervaring	Detailing the roles, tasks, and experience required for effective implementation of circular design.	Discussions that outline specific job functions and the expertise needed for sustainable project management.
Geen facilitator	Describing how a certain facilitator is not stimulating circular design,	Identification of unsuccessful facilitators or support mechanisms for implementing circularity.
Haalbaarheid	Evaluating the practicality and viability of implementing circular design principles in specific projects.	Assessments that consider the feasibility of sustainability initiatives within the constraints of the project.
Huidig AIDA punt	Analyses the current stage of the company of awareness, interest, desire, and action regarding circular practices	Evaluation of the AIDA stage for circular design for the company instead of the person itself
huidige processen	Reviewing and potentially revising current processes to better integrate circular design principles.	Instances where existing workflows are evaluated for opportunities to enhance sustainability.
Ideale situatie	Envisioning the optimal scenario for circularity implementation within projects.	Discussions about what would constitute an ideal implementation of circular design principles.
Interactie met opdrachtgever	Fostering effective communication and collaboration with clients to promote circular initiatives.	Examples of successful client engagements that lead to enhanced sustainability measures.
Invloed op welke onderdelen	Determining which components of a project can be most effectively influenced by circular design.	Analysis of project elements that are most amenable to sustainability improvements.
Kennis	Emphasising the need for specific knowledge to implement circular design effectively.	Discussions highlighting the importance of education and expertise in sustainability.

Klant heeft ambitie	Acknowledges that the client has specific sustainability goals that influence project decisions.	Instances where client-set sustainability goals are explicitly mentioned as driving factors in project planning.
Klant is initiator	Identifies clients as the primary motivators for implementing circular design practices within projects.	Examples where clients explicitly request or require circular or sustainable practices in project scopes.
Reviewen	Conducting thorough reviews to ensure circular design principles are effectively integrated into projects.	Detailed evaluations or audits of project elements to assess their sustainability.
Reviewen, Q-check	Involves systematic reviews or quality checks to ensure that circular design principles are being adhered to.	Discussions of formal review processes that specifically assess compliance with circular design standards.
RHDHV is initiator	Acknowledging Royal HaskoningDHV's role in pushing for sustainability and circular design adoption.	Discussions or instances where RHDHV actively promotes or initiates circular design practices.

Codebook COM-B and TDF

The six COM-B components and fifteen TDF domains of the BCW method were used as the codes for the BCW-based codebook. The description of the code is the common definition of the COM-B components and TDF domains as presented in the Master thesis. The inclusion criteria concerned barriers and facilitators which directly or clearly indirectly corresponded to the label.

COM-B components

1. Physical Capability
2. Psychological Capability
3. Reflective Motivation
4. Automatic Motivation
5. Social Opportunity
6. Physical Opportunity

TDF domains

1. Physical skills
2. Knowledge
3. Cognitive and interpersonal skills
4. Memory, Attention & Decision Processes
5. Behavioural Regulation
6. Social/Professional Role and Identity
7. Beliefs about Capabilities

8. Optimism
9. Intentions
10. Goals
11. Beliefs about Consequences
12. Emotion
13. Reinforcement
14. Social influences
15. Environmental Context and Resources

Appendix E. AIDA Model

The purpose of the question using the AIDA model was to inspire participants and provide them with the vocabulary to articulate their stance on circular design. This goal was achieved as participants provided more specific and detailed insights into their position on circular design. However, due to the broad definition of circularity and the numerous application methods, the question was interpreted according to personal contexts. Consequently, providing an overview of participants' positions was unreliable and therefore omitted from the results section, but was made available in this appendix.

The interview question posed to participants regarding their stance on circular design, based on the adapted AIDA model (in which the adaptation was inspired on the Customer Journey Mapping model), was broad, resulting in non-standardized responses that do not allow for a comprehensive overview of each participant's position. However, a description of participants' standings in terms of Awareness, Interest, Desire, and Action can be provided based on their interpretations.

- **Awareness and Attention**
  The interview question, utilising the AIDA and CJM models to ascertain participants' positions regarding circular design, revealed that all participants are familiar with the term circularity and the goal of water authorities to build more circular. Participants who categorised themselves under Awareness mentioned that while they are more than aware of circularity in their personal lives, they have not yet integrated it into their professional lives (D6, D13).
- **Interest**
  All participants are open to receiving knowledge passively, but there is a diversity in the willingness to actively seek out knowledge. Some participants expressed a desire to actively search for information but did not know where to look, while others were not willing to invest effort and time but found it interesting when they encountered it, learning about circular possibilities primarily through encountering.
- **Desire**
  All participants prefer sustainable designs over non-sustainable ones, provided they meet functional, financial, and comfort requirements. If two designs are equal in all aspects, with one being more circular, the circular design is preferred. Additionally, no one was opposed to incorporating circularity into designs,

although the cost to the project team differed, as well as willingness to compromise on criteria. Depending on their confidence in and acceptance of circular possibilities and the ambitions and choices of the client, participants expressed a desire to apply circular design. Several participants placed themselves in the awareness and desire categories but claimed to lack interest or knowledge in it.

- **Action**

  Some participants placed themselves in the Action phase, noting that they already apply certain circular principles, but all participants noted having still much to learn about other circular alternatives and expressed a desire to do more in the circular domain. However, even among these participants, there was little desire to invest time in expanding their knowledge.

Table 1: Cognitive stages of 22 employees on applying circular design possibilities, practices or principles on wastewater facilities designs, based on interviews

D#	Awareness	Interest	Desire	Action	Remark
D1	Yes	Passively	Moderate	Low	Aware and interested but lacks clear direction and support in applying circular principles. Finds it challenging to integrate into daily work.
D2	Yes	Yes	Yes	Moderate	High engagement with circular principles due to involvement in specific projects and active discussions with clients.
D3	Yes	Passively	Yes	Low	Became interested through initial sessions but has not fully translated this into regular practice. Still learning and exploring.
D4	Yes	Passively	Moderate	Low	Has moderate desire due to company culture but finds practical implementation difficult without more concrete guidelines.
D5	Yes	Yes	Low	Low	Recognizes the importance of circularity but lacks the initiative and practical steps to implement it effectively.
D6	Yes	Passively	Yes	Low	Positive attitude towards circular design due to a strong personal belief in its importance.
D7	Yes	Passively	Yes	Low	Interested in circular principles but feels constrained by a lack of practical examples and senior guidance.
D8	Yes	Yes	Moderate	Unintentionally	Moderate desire driven by workshop attendance but finds it challenging to apply in the absence of explicit examples. Unintentionally applies circular design by consistently applying reuse as much as possible
D9	Yes	Passively	Moderate	Low	Low interest due to a focus on traditional methods but shows some desire due to recent exposure to circular principles.
D10	Yes	Passively	Yes	Low	Shows interest and desire but feels hindered by traditional project approaches and client expectations.
D11	Yes	Yes	Moderate	Low	Aware and interested but feels the concept is still too theoretical and lacks practical support and sufficient proof to move forward.
D12	Yes	Yes	Moderate	Unintentionally	Shows moderate desire, but is sceptical on added value and needs more practical tools to take action.
D13	Yes	Passively	Low	Low	Aware of circular principles, has little knowledge and sceptical, but motivated to find win-win situations
D14	Yes	Yes	Yes	Low	Understands circularity but does not prioritise it due to workload and lack of immediate incentives.
D15	Yes	Yes	Moderate	Low	Inspired by internal discussions but lacks a clear pathway and support to implement circular designs effectively.
D16	Yes	Passively	Yes	Low	Shows interest but constrained by practical challenges and limited support from senior colleagues.
D17	Yes	Yes	Yes	Low	Interested in the concept but finds it difficult to apply without clear guidelines and support from the organisation.
D18	Yes	Yes	Moderate	Low	Moderately driven by company initiatives but needs more detailed guidance to turn desire into action.
D19	Yes	Passively	Yes	Low	Moderate interest and desire but limited by practical knowledge and organisational support.
D20	Yes	Passively	Moderate	Unintentionally	Interested but struggles to see how circular principles can be practically applied in their specific projects.
D21	Yes	Passively	Yes	Low	Motivated by company initiatives but lacks detailed practical knowledge and support to implement circular actions.

D22	Yes	Yes	Yes	Moderate	Aware and interested but does not prioritise circular principles due to existing workload and lack of direct incentives.

Appendix F. Explorative analysis

In this appendix, the results from the explorative analysis using ATLAS.ti are documented. This section highlights the identified barriers and facilitators to circular design, presenting a systematic categorization and summarization of the themes that emerged from the qualitative data.

Results from atlas.ti

Results of explorative coding round in ATLAS.ti, in table form, formatted and colour coded:

		Civil				Electrical			Hydraulic			Mechanical					Process eng.	Project-management			Management			C	E	H	M	PE	IPM	Management
Barrier	**Count**	**D1**	**D10**	**D13**	**D21**	**D7**	**D12**	**D20**	**D2**	**D19**	**D22**	**D4**	**D8**	**D11**	**D14**	**D16**	**D15**	**D3**	**D17**	**D18**	**D5**	**D6**	**D9**							
Conservatisme en routine	18	x	x	x	x	x	x		x	x	x	x	x	x		x	x	x		x	x		x	4	2	3	4		2	2
Drukte (2)	7	x	x								x						x				x	x	x	2	0	1	0		0	3
Collega's zijn er niet mee bezig	6	x							x			x	x								x	x		1	0	1	2		0	2
Negativiteit collega's/markt	4	x					x											x				x		1	1	0	0		1	1
Commerciële organisatie	3													x							x		x	0	0	0	1		0	2
Esthetisch	2								x					x										0	0	1	1		0	0
Fasering	2												x	x										0	0	0	2		0	0
Technische functionele eisen - kwaliteit	17		x	x		x	x	x	x	x	x		x	x	x	x	x	x	x	x		x		2	3	3	4		3	1
Nieuw idee heeft minder zekerheden	5			x	x								x	x				x						2	0	0	2		1	0
Ruimte m2	4			x			x									x	x							1	1	0	1		0	0
Onduidelijkheid, onbekend, mist kennis	20	x	x	x	x	x	x	x	x		x	x	x	x	x	x		x	x	x	x	x	x	4	3	2	5		3	3
Twijfel over mogelijkheden	9			x		x	x	x		x			x	x	x	x								1	3	1	4		0	0
Handvaten	3		x										x									x		1	0	0	1		0	1
RHDHV ambitie onduidelijk	3									x									x				x	0	0	1	0		1	1

Woord C misleidend	2			x				x																1	1	0	0		0	0
Geen verwachting willen stellen aan mensen die het niet kunnen	1																					x		0	0	0	0		0	1
Klant (2)	18	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x		x	x		x	4	3	2	4		2	2
Kosten en Klant budget	17	x	x	x	x		x	x	x			x	x			x	x	x	x	x	x	x	x	4	2	1	3		3	3
Beheerders tevredenheid en gemak	12	x		x	x	x	x		x	x	x		x	x	x			x						3	2	3	3		1	0
Geen klant contact	2		x									x												1	0	0	1		0	0
Scepsis over toegevoegde circulariteit/nut, geen geloof in, kritisch op	10			x		x	x	x					x	x	x		x			x		x		1	3	0	3		1	1
Te zweverig en onrealistisch ideeën	6				x			x			x	x	x							x				1	1	1	2		1	0
Irritatie over poppenkast	4			x				x					x							x				1	1	0	1		1	0
Pessimisme over uitvoerbaarheid en mogelijkheden	3						x											x		x				0	1	0	0		2	0
Onwennig	2						x										x							0	1	0	0		0	0
Ergens anders grotere winst te halen	1	x																						1	0	0	0		0	0
MKI berekening tool	5											x	x	x	x							x		0	0	0	4		0	1
Gegevens voor MKI	4						x						x	x	x									0	1	0	3		0	0
Kost moeite, kost energie	10	x	x	x		x	x						x	x			x				x		x	3	2	0	2		0	2
Vergeten C te doen, niet mee bezig	9					x	x	x	x	x		x				x		x					x	0	3	2	2		1	1
Te laat in proces C meenemen	3									x	x								x					0	0	2	0		1	0

Niet doorvragen of bij stil staan	1														x									0	0	0	1		0	0
Verstorend voor werkproces	1																x							0	0	0	0		0	0
Niet diens taak of rol	8	x		x						x	x	x	x				x					x		2	0	2	2		0	1
Kost tijd	14	x	x		x	x	x				x	x			x	x	x	x			x	x	x	3	2	1	3		1	3
Strakke tijdsplanning project	8				x							x				x	x	x		x		x	x	1	0	0	2		2	2
Veel werk, weinig mensen in de markt	2	x																					x	1	0	0	0		0	1
Al goed bezig op andere milieu-punten	7	x				x	x	x			x		x	x										1	3	1	2		0	0
Complexe afweging	6			x	x		x							x		x	x							2	1	0	2		0	0
Andere zaken belangrijker	5			x			x						x	x	x									1	1	0	3		0	0
Eensgezindheid (2)	5		x							x				x					x		x			1	0	1	1		1	1
Er zijn gewoon echt geen mogelijkheden (Elektro)	4					x		x			x		x											0	2	1	1		0	0
Gemakkelijk tot resultaat komen	4										x		x	x			x							0	0	1	2		0	0
Ongewenste verplichting	4	x					x										x					x		1	1	0	0		0	1
Realisatiehobbel	4	x	x	x														x						3	0	0	0		1	0
Geen drive voor C uitzoeken	3			x													x					x		1	0	0	0		0	1
Geen herbruikbare onderdelen beschikbaar	2															x	x							0	0	0	1		0	0

Resulting barriers and facilitators

All Barriers

All barriers mentioned by participants in the interviews are as follows: an alternative design method is not part of the routine, leading to circularity being overlooked or feeling unfamiliar. Additionally, circular design clashes with the traditional design method, causing disruption in a hybrid combination. It is noted that the term circularity is misleading, abstract, and unclear, and that the concrete design methods are unknown, with no experience or examples available, resulting in engineers lacking the necessary knowledge and skills. Furthermore, it is unknown where to obtain this knowledge, examples, guidelines, and experience, or who to approach for development in this area. There is a lack of data and a calculator to determine the MKI value of components and designs. Learning, researching, applying, and transitioning to a circular design method is not done due to lack of time, opportunity, energy, mental space, and willingness (partly due to high workload and high market demand). Rather, the design must be proven, reliable, and faultless in terms of functional requirements, and there is doubt, criticism, scepticism, irritation, and cynicism about the existence, adequacy, and feasibility of circular possibilities and the added environmental value of these circular alternatives. Additionally, the moral obligation to design circularly decreases when there is a perception that greater, easier, or more effective sustainability gains can be achieved in other sustainability areas besides circularity, and when one is already performing well in other sustainability aspects.

Moreover, the client aspires to circular designs but is unwilling or barely willing to compromise on other requirements, such as budget, functionality, maintenance comfort, time planning, phasing, site area, and aesthetics, and has a preference for the familiar (conservatism). Consequently, the engineer's experience and expectation is that the client will choose a traditional design over a circular one, which has a demotivating effect. This demotivating expectation leads to prioritising other aspects above circularity. Additionally, there is no clear division of roles regarding who is responsible for ensuring the circularity of the process. In several projects where circularity was unsuccessfully or barely applied, the timing of circular dedication was too late in the process. It is mentioned that within RHDHV, the ambition regarding circularity is unclear, colleagues are not engaged with it or have a negative attitude towards it, and the company's commercial objective conflicts with pro bono time investment for circular designs for projects budgeted for a traditional design process.

Table 1: Description of main barriers in circular design adoption

Barrier	Description of barriers*
Lack of clarity and knowledge	Mentioned 99 times over 20 interviews with something to be unclear, unknown, or the interviewees' knowledge to be insufficient to apply circular design. The remaining 2 participants (D15 and D19) had previously undergone a circularity training, but still noted that there was more to learn. The quotes related to this barrier were divided into the following categories: Lack of knowledge about the definition and understanding of circular design; lack of concrete knowledge about sustainable materials and alternatives; unknown sources of knowledge and tools; lack of in-depth understanding and practical experience; and no knowledge about how to nudge clients towards circular design.
Costs	Costs play a crucial role in the decision to implement circularity, encompassing both design and realisation expenses. It is emphasised that projects often need to adhere to strict budgets, leaving little room for experimenting with more sustainable but potentially more expensive solutions. This viewpoint is highlighted by several participants that high costs are associated with circular alternatives, which often leads to a prioritisation of cheaper, traditional solutions.
Practical Feasibility and Functional Requirements	Practical challenges also represent a significant barrier. It was noted that reusing materials, such as old tanks or pumps, carries risks due to unknown lifespan and reliability. This sentiment is echoed by other respondents who stress that the reliability and functionality of the installation must always come first, and circularity should not compromise these primary requirements.
Process within organisation	The results point to a lack of clear responsibility and ownership regarding circularity. This implies that circularity is not currently considered a core part of project objectives, but rather a secondary aspect addressed when circumstances permit. The implication is that without clear allocation of responsibilities and integration into core processes, circular initiatives will remain fragmented and inconsistent, leading to inconsistent application of circular principles and a lack of measurable progress in this area.
Time constraints	The results mention time-investment to be a barrier on itself, and a consequence of the barrier Costs (Budgetary requirements). Both learning the new concepts of circular design, as well as the act of circular design takes more time than is currently available to an engineer, resulting in falling back to the default traditional design.

* For more information: see appendix Exploratory Analysis.

Barrier: Lack of clarity and knowledge

In 20 interviews, it was mentioned 99 times that something was unclear, unknown, or that the interviewees' knowledge was insufficient to apply circular design. The remaining 2 participants (D15 and D19) had previously undergone a circularity training, but still noted that there was more to learn. The quotes related to this barrier can be divided into the following categories: Lack of knowledge about the definition and understanding of circular design; lack of concrete knowledge about sustainable materials and alternatives; unknown sources of knowledge and tools; lack of in-depth understanding and practical experience; and no knowledge about how to nudge clients towards circular design.

- **Lack of knowledge about the definition and understanding of circular design**

Many participants exhibited no clear understanding of what circularity exactly entails (D5, D12, D13, D20). There was considerable uncertainty about circular goals, ambitions, and what is considered sufficiently circular (D4, D9, D12, D17). Additionally, a significant number of interviewees lacked knowledge and understanding of the basic principles of circular design (D4, D5, D12, D13, D17, D18).

- **Lack of concrete knowledge about sustainable materials and alternatives**
  Participants were generally not sufficiently aware of available circular materials and their properties (D1, D3, D7, D11, D13, D14, D16, D20–D22). Many were also unfamiliar with current circular technologies, such as Verdygo (D1, D7, D11, D13, D14, D16, D17, D20, D21). Additionally, other concrete circular possibilities, alternatives, and construction methods were largely unknown (D3, D7, D11–D14, D16–D18, D20–D22). There was missing information and uncertainty about the functionality of circular materials, reused or circular components, or alternative design choices, especially in terms of how they meet functional requirements (D8, D11, D13, D17, D21, D22). Participants also mentioned a lack of clarity on the extra costs associated with circular design and the benefits in terms of CO_2 / MKI (D3, D8, D13, D14, D21). Moreover, there was uncertainty about how to determine the best alternative from a sustainability perspective (D3, D4, D8, D11, D13, D14, D16, D21, D22).
- **Unknown sources of knowledge and tools**
  Participants expressed unfamiliarity with where and how to find new knowledge and information (D1, D3, D4, D20–D22). There was also a lack of awareness regarding the existence of tools (e.g., Dubocalc) for material selection or guidelines, or knowledge about where to find these resources (D6, D14).
- **Lack of in-depth understanding and practical experience**
  There was insufficient understanding of and experience with the current design process to practically apply circularity to projects, a concern particularly noted by junior participants (D1, D10). Additionally, there was a lack of creativity and ability to design circular solutions (D2, D6), and it was unclear what was expected of engineers in terms of circularity and in the design process (D9, D18).
- **No knowledge about how to nudge clients towards circular design**
  Participants reported no knowledge or tools on how to counter client standards or effectively persuade clients to choose circular alternatives (D1). There was uncertainty about how to structure communication regarding the benefits and trade-offs of circular design. Furthermore, there was a lack of knowledge about

the marketplace or the client's inventory of available parts that could be reused (D3).

Barrier: Costs

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Barrier: Practical Feasibility and Functional Requirements

Practical challenges also represent a significant barrier. It was noted that reusing materials, such as old tanks or pumps, carries risks due to unknown lifespan and reliability. This sentiment is echoed by other respondents who stress that the reliability and functionality of the installation must always come first, and circularity should not compromise these primary requirements

All Facilitators

In response to the interview question regarding what motivates or supports participants to apply circular design more frequently, a large and varied number of facilitators were identified by the participants. The most frequently mentioned facilitators are as follows:

- **Client**-Related Facilitators (mentioned in all of the 22 interviews): Participants noted the importance of clients actively requesting and prioritising circular design (18 interviews) or RHDHV successfully pushing, persuading, and questioning the client (17 interviews).
- **Knowledge**-Related Facilitators (mentioned in all interviews): These included training and education (16 interviews); actively seeking knowledge and understanding the possibilities (both mentioned in 14 interviews); having examples to refer to (12 interviews); and advising and teaching circularity expert (12 interviews); possessing broad knowledge through experience with diverse projects (12 interviews) and knowledge shared by colleagues (11 interviews).
- **Process**-Related Facilitators: Making circularity a standard part of the design process (17 interviews), of which was mentioned, both directly and indirectly, the tender phase (4 interviews), the kick-off meeting (12 interviews), the phase of system selection and MCA (6 interviews), VO/DO phase (5 interviews), and the

material selection phase (1 interview). Also the method of tasking a team member with the responsibility to check up on circularity investment was mentioned (12 interviews)

- **Time**-Related Facilitators: Creating time and thereby space for circular design (11 interviews).

Successes

Several circular elements have already been successfully implemented or are present in the traditional design process. Driven by financial incentives, convenience, or time savings, it is already common practice to investigate and take inventory which systems can possibly be reused, as well as encourage, whereand where possible, reuse and minimal construction are encouraged. Additionally, the ambitions of the Water authorities are well-known among the engineers, which has resulted in a heightened awareness of circularity. Furthermore, some circular project examples, particularly the wooden pipeline bridge (mentioned in nine9 interviews), are well-known among the participants.

Facilitators

In the interviews, a variety of facilitators were mentioned that would promote the application of circular design. The following aspects were highlighted: If clients supported circular design by actively aspiring to it, prioritising it, coming up with ideas, providing available existing components, accepting standardisation, and calculating a higher budget, the demand side would change. RHDHV can also be successful by nudging, persuading, and questioning the client to select a circular design by showing confidence, bluffing, daring, and fighting for circular alternatives, or by leveraging other incentives such as cost or time savings. Conversely, the more budget, terrain area, and time is allocated for the project, the more room there is for circularity. Involving the Maintenance actor in the design process was also highlighted as beneficial.

A wider knowledge base, specifically regarding circularity and MKI information, practical and detailed knowledge about application, insight into possibilities, and examples and best practices, can also contribute. This can be achieved through easily accessible knowledge, actively seeking and researching knowledge, training and education, learning on the job, and learning from knowledgeable colleagues or external sources such as trade fairs, professional journals, and LinkedIn.

The process itself can also be improved by ensuring circularity is secured in the bidding phase, expressing ambition in the initial meeting, implementing large-scale material savings and reuse in system selection phase, conducting a scan for reusable components, and applying small-scale reuse and circular material choices in the VO/DO phase. Regular control and inclusion on the agenda or through mandatory documents might also help. This could be facilitated by assigning a team member to check in and query the team on the circularity element. A second function version would be to have someone who can offer expertise, tips, and advice. A third role is to have experienced experts (from outside the project team) who can spot circular possibilities.

Motivation, optimism, enthusiasm, and interest are also cited as facilitators. These grow as individuals become more involved, enjoy their work, and recognize the benefits and feasibility of circular design choices. Ease of knowledge acquisition and application, as well as final design, also play a role. A step-by-step and feasible approach, starting by identifying circular opportunities and then acting on them, is mentioned.

Goals (, both ambition goals and strict requirements), can help, through whichwith non-compliant individuals arereindivaiduals being reprimanded and cooperative individuals arebeing recognized and rewarded. Having time, space, and a lower workload is beneficial, as is facilitating tools such as the MKI tool, checklists, guidelines, and lists of circular alternatives. Colleagues encouraging each other and making circularity a hot topic within the company are also seen as beneficial.

Sustainability Sessions

According to the interviews, sustainability sessions are most effective in the project when (i) there is an ambition discussion occurs during the kick-off meeting, (ii) brainstorming sessions are scheduled to identify concrete circularity opportunities, and (iii) circularity is made a standard agenda item in meetings. Following that, both the customer and RHDHV should work together to pursue these opportunities as part of the design process (rather than as a separate step). It was observed that having a team member in charge of circularity improves the success of the sustainability session.

Involvement of every actor

Participants mentioned that changes are needed on various fronts: project management is the most obvious role to ensure the presence and safeguarding of circularity in the project. Engineers are thereby asked to engage more with circularity, creating motivation and priority to expand their knowledge of circularity. Management can stimulate circular design by facilitating more time, budget, and tools. Additionally, the client needs to have a positive and clear attitude towards circularity and should invest effort and budget to realise circular design choices where possible.

Timing

It was also mentioned that it is motivating to incorporate circularity from the beginning of a project because the greatest circular benefits can be achieved early on. Later, from the VO/DO phase onwards, the choices become more fixed, resulting in less freedom for the engineers.

Circular Job Functions

Multiple ideas have been suggested for creating job roles and expanding responsibilities to ensure circularity in the process, providing support, and serving as a role model. (i) Project managers could be given the additional responsibility of prioritising circularity in projects, steering towards sustainable outcomes by applying circular principles from the design phase through to execution and maintenance. Additionally, (ii) a team member within a project team could be tasked with checking, questioning, and encouraging circularity. (iii) A new role could be created for advisors in Circular Economy to inform, advise, and activate clients and other stakeholders about integrating circular design into projects and policies. Furthermore, (iv) a more active role could be established for circularity experts who can quickly and accurately assess opportunities in projects and intervene in ongoing projects (in the VO phase) to evaluate and enhance circularity. Also, (v) engineers who specialise themselves in sustainable materials that meet technical requirements, and (vi) engineers proficient in calculating MKI could function as a helpdesk for inquiries and determining the better alternative between two options. Moreover, (vii) experienced engineers could be recruited or trained to implement circular design in a structured and efficient manner, serving as role models. Finally, (viii) the current circularity team could be expanded and diversified to increase its scope.

Interpretation

The solutions, opportunities, and successes mentioned in the interviews were analysed, as proposing a solution can indicate the problem for which the solution was formulated. Many ideas were suggested regarding timing, additional job roles, sustainability sessions, overcoming knowledge barriers (such as lack of time and space), and involving clients in circular designs.

An important facilitator for success appears to lie in the timing and approach of sustainability sessions. Many respondents indicated that these sessions are often not optimally timed or integrated, resulting in misalignment between design and sustainability goals. By better timing and structuring sustainability sessions, circularity goals can be more effectively integrated into the design process. This can be achieved, e.g., by asking fundamental questions during the system selection phase such as: "Is this building really necessary?" and "Can we reuse instead of building new?"

Appendix G. BCW Analysis

This appendix elaborates on the outlined application of the BCW in the results section.

COM-B components and TDF domain with barriers

Table 1: COM-B Component hinders behaviour

	Physical Capability	Psychological Capability	Reflective Motivation	Automatic Motivation	Social Opportunity	Physical Opportunity
D1		x	x	x	x	x
D2		x	x			x
D3		x	x			x
D4		x			x	x
D5		x			x	x
D6		x		x		x
D7		x	x	x		x
D8		x	x			x
D9		x	x		x	x
D10		x			x	x
D11		x	x			x
D12		x				x
D13		x	x	x		x
D14		x	x			
D15						x
D16		x	x	x	x	x
D17		x			x	x
D18		x	x		x	
D19		x	x		x	x
D20		x	x	x	x	x
D21					x	x
D22		x			x	x
COUNT	0	20	13	6	12	20

Table 2: COM-B Component aids implementation

	Physical Capability	Psychological Capability	Reflective Motivation	Automatic Motivation	Social Opportunity	Physical Opportunity
D1			x		x	
D2		x	x		x	
D3			x		x	
D4						x
D5			x			
D6			x			
D7						
D8			x	x		
D9						
D10						
D11					x	
D12			x		x	x
D13			x			
D14			x			
D15			x			x
D16		x	x			x
D17		x			x	
D18						
D19		x	x			
D20						
D21		x	x			
D22		x	x			
COUNT	0	6	14	1	6	4

Table 3: Comparison of counted barriers and facilitators, and content of drivers

	Barrier identified Amount of interviews	**Facilitator identified** Amount of interviews	**Facilitators (+) and Barriers (-)**
Physical Capability	0	0	
Psychological Capability	19	6	+ Experience with re-use principle + Familiarity with several circular example projects - Lack of understanding of circularity, its possibilities, examples, design strategies, implementation methods, and impact evaluation - Forgetting to consider circularity - Perception of circularity as difficult, complex, and abstract
Reflective Motivation	13	14	+ Moral value of sustainability + Requires creativity + Openness to the idea + Belief in and expectation of more possibilities - Prioritising comfort and functionality - Doubts about feasibility - Unwillingness to invest personal time to develop knowledge - Scepticism about the benefits (e.g., is the circularity worth the higher cost and lower quality)
Automatic Motivation	6	1	+ Normalisation of reuse - Frustration over the new term for the old reuse principle - Routine behaviour in design methodology - Infrequent consideration of circularity
Social Opportunity	12	6	+ Client questioning engineers about circularity - Limited engineer influence on client decisions - Minimal colleague engagement with the topic - Project deadlines and workload prioritised over circularity - Unclear responsibility and leadership for circularity
Physical Opportunity	20	4	+ Client aspires circularity + Sustainability sessions + Circularity as part of the MCA - Client requirements - Lack of time and opportunity - Absence of tools

Content of TDF per COM-B

For an in-depth analysis of what needs to change, the barriers were categorised according to the Theoretical Domains Framework (TDF) domains. Many barriers overlapped or were indirect causes of various TDF domains. For instance, “client declined circular design choice” influenced Social Influences, Environmental Context and Resources, Reinforcement, Beliefs about Capability, and Optimism. Due to the inherent subjectivity of the categorisation of barriers in TDF domains, TDF domains are merely qualitatively analysed.

Physical Capability: The capability to physically perform a behaviour.

- **Skills (Physical skills)**
  Engineers possess the necessary physical capabilities for their tasks, whether for applying traditional, circular, or combined design methods.

Psychological Capability: The capability to have the necessary knowledge and mental processes to perform a behaviour.

- **Knowledge**
  Interviews indicate a significant lack of understanding regarding what circularity entails and how it can be applied in design practices. Several participants mentioned being unaware of the broader definition of circularity, which includes aspects such as reducing material usage. Many engineers have only a superficial understanding of circularity, typically limited to the reuse of components and materials, without a comprehensive grasp of its broader implications, possibilities, and alternatives. Furthermore, there are misunderstandings or incorrect knowledge about circular design, leading to the belief that it is not feasible within their field or specific projects.
- **Skills (Cognitive and interpersonal skills)**
  Interviews revealed that many engineers lack the specific skills or creativity needed for circular design. They have not received training in the available methods, techniques, and solutions associated with circular design, nor do they know how to apply life cycle analysis or environmental impact assessments (MKI calculations). This skills gap means they do not know how to integrate circular principles into their design projects.
- **Memory, Attention & Decision Processes**
  A significant barrier is that engineers often revert to traditional design practices out of habit. There are no structured reminders or tasks to help them consistently apply circular design principles, causing them to stick to familiar methods even when circular options are available and feasible.
- **Behavioural Regulation**
  No engineers were found to engage in self-monitoring or actively break old habits. Interviews highlighted a lack of systematic feedback and support to help them

adjust and improve their design practices. This makes it difficult for them to effectively integrate circular design principles into their work.

Social Opportunity: The social and interpersonal factors that influence behaviour.

- **Social Influences**
  There is a clear influence of the social environment on engineers' behaviour regarding circular design. Interviews indicate that the culture within organisations often does not support circular design. Engineers experience a lack of support and encouragement from colleagues and supervisors, making them feel isolated in their efforts to implement circular design principles. Other team members often show little interest in circular design, contributing to a sense of loneliness and lack of support for these methods. Additionally, supervisors frequently prefer traditional methods and do not encourage circular design, which is demotivating for engineers. Organisational culture is often focused on quick, cost-effective solutions rather than sustainable designs, making it difficult for engineers to promote circular principles. Client expectations also play a role: engineers feel social pressure to meet traditional client expectations, even if they are not aligned with circular solutions. Especially when clients demand contradictory requirements, such as sustainability without additional costs, it becomes challenging for engineers to implement circular design principles. This leads to discouragement, particularly when clients are unwilling to pay extra for circular design.

Physical Opportunity: The physical environment and resources necessary to perform the behaviour.

- **Environmental Context and Resources**
  The physical resources needed for circular design are often unavailable or inadequate. Engineers report a lack of specific tools, software for lifecycle analysis and environmental impact assessments (MKI calculations), and access to reusable components and sustainable materials essential for applying circular design methods. Additionally, tight deadlines and limited budgets are significant barriers, making it difficult to take the extra steps needed for circular design. There is also often no budget available for purchasing sustainable materials or conducting MKI calculations. Engineers face time constraints due to project deadlines, leaving no room to fully follow the steps of the circular design process. Moreover, the functional requirements of a project sometimes cannot be reconciled with circular

designs, further limiting the physical possibility of applying these methods. Unfamiliarity with existing circular solutions poses an additional challenge. Engineers often doubt whether suitable circular materials or technologies are available for their projects due to a lack of information or access to these solutions. This highlights the need for better support and resources to promote circular design within organisations.

Reflective Motivation: The conscious decisions, plans, and evaluations that lead to the behaviour.

- **Social/Professional Role and Identity**
  Interviews indicate that the professional role and identity of engineers are often strongly connected to their technical expertise and ability to provide practical, cost-effective solutions. Engineers see themselves as experts delivering high-quality, sustainable designs according to established standards. The introduction of circular design is seen by some as a challenge to their professional competence, especially when they feel they need to develop additional skills outside their current expertise. For others, circular design is an integral part of being a good advisor to the client.
- **Beliefs about Capabilities**
  Multiple engineers doubt their ability to successfully apply circular design. This is exacerbated by a lack of examples and successes demonstrating that circular design is feasible and effective. Some interviewees expressed that they do not always trust the quality and durability of circular solutions, especially when they are sceptical about their benefits and practicality. These doubts can also stem from experiences where clients, despite their ambition to be circular, ultimately prefer traditional solutions, discouraging engineers from proposing circular methods.
- **Optimism**
  Optimism among engineers regarding the feasibility and benefits of circular design is generally low. Many participants doubt the effectiveness of circular methods and are reluctant to embrace them without convincing evidence of their success. This pessimism is often fueled by negative experiences or misunderstandings about circular design. Several engineers expressed doubts about the actual benefits of circular design, citing examples of projects where circular measures were taken without clear improvement in sustainability or efficiency.
- **Intentions**

Although many engineers are positive about the idea of circular design, there is often a lack of strong intention to actually apply these principles. This is partly due to a lack of engagement and support from the organisation to prioritise circular design. Engineers do not always feel motivated to integrate circular design methods without clear incentives or recognition of their efforts. One engineer mentioned being open to circular design but prioritising meeting traditional quality standards and client expectations. Additionally, they often find that clients, despite their stated ambition for sustainability and circularity, ultimately choose traditional, less sustainable designs.

- **Goals**

  There are often no clear and specific goals set for implementing circular design within projects. Engineers indicate that there are no measurable targets or guidelines motivating them to apply circular principles. Without clear goals, circular design remains an abstract unprioritized concept without concrete application in their daily work, according to several engineers.

- **Beliefs about Consequences**

  Engineers' beliefs about the consequences of circular design are often negative. Many believe circular designs to be more expensive, requiring more effort from Maintenance, or not meeting client quality standards. These beliefs are a significant barrier to accepting and implementing circular design principles. One engineer mentioned being sceptical about the durability of circular materials, fearing they would need to be replaced more quickly, resulting in higher costs and efforts. There is also the widespread belief that clients, despite their circular ambitions, often revert to traditional choices, further discouraging engineers from proposing circular methods. In contrast, there is a high willingness among engineers to contribute to a sustainable world and the expected positive effect of a situation when a circular design is realised.

Automatic Motivation: The automatic, often unconscious processes such as habits and emotions that influence behaviour.

- **Emotion**

  Interviews reveal that emotional factors, such as reluctance to change and uncertainty about new methods, are significant barriers to adopting circular design methods. Engineers are accustomed to traditional practices and feel uncomfortable with the idea of circular design. Emotional resistance and unconscious biases, such as the notion that circular design is less efficient, reinforces these feelings. Fear of making mistakes and uncertainty about unfamiliar methods lead to a preference for the familiar, traditional approach, causing frustration with change.

- **Reinforcement**

  Reinforcement plays a role in the resistance to circular design because engineers have the unconscious preference for traditional methods as those are familiar and comfortable. Many follow existing procedures automatically and unconsciously stand negatively or critically to new ideas. This preference for ease and avoidance of cognitive effort leads them to stick to familiar methods, solutions, and materials. Positive experiences with traditional methods and negative experiences with change reinforce the tendency to reflexively make traditional choices, hindering the adoption of circular methods. Additionally, experience shows that clients, despite their ambition to be circular, often prefer traditional designs. This makes engineers reluctant to use circular methods, as they expect the client will ultimately choose the familiar approach. This inconsistency between client ambitions and their final choices reinforces engineers' hesitation to adopt new circular approaches.

Intervention functions

Evaluations of intervention functions across APEASE criteria for each COM-B component. Though evaluations are contain a subjective component, a systematical selection based on APEASE criteria, aims to counter this subjectivity.

COM-B Component	Intervention Function	Accept ability	Practic ability	Effecti veness	Afford ability	Side-Ef fects	Equity	Remarks
Psychologica l Capability	Education	High	High	High	Medium	Low	High	Ideal for increasing understanding and knowledge.
	Training	High	Medium	High	Medium	Low	High	Effective for skill development but resource-intensive.
	Enablement	Medium	Medium	High	Medium	Low	High	Supports overcoming psychological barriers.
Physical Opportunity	Training	High	Medium	High	Medium	Low	High	Useful for adapting behaviors to new environments.
	Restriction	Low	High	High	High	Medium	Low	Can be effective but may be perceived as limiting freedom.
	Environmental Restructuring	Medium	High	High	High	Low	Medium	Changes the physical context to enable better behaviors.
	Enablement	High	Medium	High	Medium	Low	High	Provides tools or changes to increase physical opportunities.

Social Opportunity	Restriction	Low	High	High	High	Medium	Low	Restrictions might not be well accepted socially.
	Environmental Restructuring	Medium	High	High	High	Low	Medium	Modifies social settings, impacting interactions.
	Modeling	High	High	High	Medium	Low	High	Demonstrates desirable behaviors within social contexts.
	Enablement	High	Medium	High	Medium	Low	High	Facilitates social engagement and support.
Automatic Motivation	Incentivisation	High	Medium	High	Medium	Low	Medium	Rewards can motivate but may not sustain behavior.
	Coercion	Low	High	High	Low	High	Low	Effective but can lead to resistance or negative reactions.
	Training	High	Medium	High	Medium	Low	High	Reinforces automatic responses through practice.
	Environmental Restructuring	Medium	High	High	High	Low	Medium	Alters contexts that trigger automatic behaviors.
	Modeling	High	High	High	Medium	Low	High	Observation and imitation of behaviors can shape habits.
	Enablement	High	Medium	High	Medium	Low	High	Empowers and supports the development of new automatic behaviors.
Reflective Motivation	Education	High	High	High	Medium	Low	High	Increases awareness and reflective decision-making.
	Persuasion	High	High	Medium	Medium	Low	High	Can change attitudes but may not lead to action.
	Incentivisation	High	Medium	High	Medium	Low	Medium	Motivates through rewards but may not affect deep beliefs.
	Coercion	Low	High	High	Low	High	Low	Can compel behavior change but often resented.
	Environmental Restructuring	Medium	High	High	High	Low	Medium	Facilitates new habits by altering decision environments.
	Modeling	High	High	High	Medium	Low	High	Role models can profoundly influence reflective choices.
	Enablement	High	Medium	High	Medium	Low	High	Enhances ability to engage in reflective thinking and behavior change.

Policy categories

Evaluating relevant policy categories per intervention function

Policy Category	**Interventio n Function**	**Accept ability**	**Practic ability**	**Effectiv eness**	**Afforda bility**	**Side-Ef fects**	**Equity**	**Remarks**
Communica tion/Market ing	Education	High	High	High	Medium	Low	High	Education and awareness campaigns can be effective in informing engineers about circular design, but can be expensive due to the required marketing resources.
	Persuasion	High	High	High	Medium	Low	High	The use of communication to promote the benefits of circular design can be effective, but may require significant resources to develop and disseminate convincing messages.

	Incentivisation	Medium	Medium	High	Medium	Low	High	The use of incentives through communication can be acceptable, but requires resources to implement effectively. It can help highlight the benefits of circular practices.
	Modeling	High	High	High	Medium	Low	High	Using communication to show successful examples of circular design can be very effective in inspiring others, but is resource-intensive.
Guidelines	Education	High	High	High	Medium	Low	High	Guidelines can provide clear information on how to integrate circular design into projects, which is very useful for engineers at RHDHV.
	Persuasion	High	High	High	Medium	Low	High	Guidelines that emphasize the benefits and methods of circular design can be effective in stimulating behavior change.
	Incentivisation	High	High	High	Medium	Low	High	Guidelines that describe how incentives can be applied can help promote circular practices.
	Training	High	High	High	Medium	Low	High	Guidelines can offer cost-effective ways to deliver training content and ensure consistency in learning processes.
	Environmental Restructuring	High	High	High	Medium	Low	High	Guidelines can assist in planning and implementing environmental restructuring that promotes circular design.
	Enablement	High	High	High	Medium	Low	High	Guidelines that provide instructions on facilitating access to resources and support can be very useful.
Fiscal Measures	Incentivisation	Medium	Medium	High	High	Medium	High	Fiscal measures such as tax benefits can be effective in encouraging circular practices, but may face acceptance issues and carry costly compliance costs.
	Training	Medium	Medium	High	High	Medium	High	Subsidies for training programs can be effective, but require significant resources and administrative support.
	Environmental Restructuring	Medium	Medium	High	High	Medium	High	Fiscal incentives to encourage investment in circular infrastructure can be effective but require complex coordination and compliance.
	Enablement	Medium	Medium	High	High	Medium	High	Fiscal incentives to facilitate access to resources and support can be effective, but require significant resources.
Regulation	Education	High	Medium	High	Medium	Medium	High	Regulation requiring mandatory education programs can be effective but may face resistance and incur enforcement costs.
	Persuasion	High	Medium	High	Medium	Medium	High	Regulation that enforces communication and transparency about circular design can be effective but may cause acceptance problems.
	Incentivisation	Medium	Medium	High	High	Medium	High	Regulation that provides fiscal incentives for circular design can be effective but may be difficult to enforce and carry compliance costs.
	Training	High	Medium	High	Medium	Medium	High	Mandatory training for engineers on circular design can be very effective but requires significant resources and may face resistance.

	Environmental Restructuring	High	Medium	High	High	Medium	High	Regulation that requires environmental restructuring to support circular practices can be effective but difficult to implement.
	Enablement	Medium	Medium	High	High	Medium	High	Regulation can facilitate access to resources and support, but may cause acceptance and affordability issues due to compliance costs.
Legislation	Education	High	Medium	High	Medium	Medium	High	Legislation mandating education programs can be effective but may provoke resistance and incur costly enforcement expenses.
	Persuasion	High	Medium	High	Medium	Medium	High	Legislation enforcing transparency and reporting on circular design can be effective but may cause acceptance issues.
	Incentivisation	Medium	Medium	High	High	Medium	High	Legislation providing fiscal incentives for circular design can be effective but may be difficult to enforce and carry compliance costs.
	Training	High	Medium	High	Medium	Medium	High	Mandatory training for engineers can be very effective but requires significant resources and may encounter resistance.
	Environmental Restructuring	High	Medium	High	High	Medium	High	Legislation requiring environmental restructuring can be effective but difficult to implement.
	Enablement	Medium	Medium	High	High	Medium	High	Legislation can facilitate access to resources and support, but may cause acceptance and affordability issues due to compliance costs.
Service Provision	Education	High	Medium	High	Medium	Low	High	Offering workshops and training specifically targeted at circular design can be very effective but requires significant resources and planning.
	Persuasion	High	Medium	High	Medium	Low	High	Offering services to persuade customers of the benefits of circular design can be effective but requires resources and collaboration.
	Incentivisation	High	Medium	High	Medium	Low	High	Offering financial incentives or subsidies for circular design initiatives can be very effective but requires resources and administrative support.
	Training	High	Medium	High	Medium	Low	High	Offering specific training and development for engineers can directly improve their skills and knowledge about circular design but requires significant resources.
	Modeling	High	Medium	High	Medium	Low	High	Offering services that demonstrate models of circular design can be very effective but requires significant resources.
	Enablement	High	Medium	High	Medium	Low	High	Providing resources and support to implement circular design can be very effective but is costly.

Interventions combinations

	Content	BCTs	Mode of delivery	Source of intervention
Practical Training and Instruction	Inform, educate and instruct through practical training sessions and materials; educate an action plan on how to perform circular design behaviour; inform how and where to find guidelines, information and support (BCT 1.4, 4.1, 8.1, 8.7, 9.1).	1.4 Action Planning 4.1 Instruction on how to perform a behavior 8.1 Behavioral practice/rehearsal 8.7 Graded tasks 9.1 Credible source	**Live Content**: Interactive seminars and hands-on workshops are ideal for delivering real-time, practical training where engineers can learn through discussing and doing. These sessions facilitate immediate feedback and colleague-to-colleague learning, enhancing the educational experience. **Digital Media**: Interactive online courses and webinars provide flexibility, allowing engineers to learn at their own pace, access on-demand and revisit complex topics as needed. These media can demonstrate best practices, showcase successful case studies, and provide step-by-step guides on circular design methods. And can include quizzes, simulations, and interactive discussions to reinforce learning. **Print Media**: Manuals, guides, and checklists can support ongoing learning and serve as quick reference tools during project execution.	**Experts/Trainers**: Professional trainers with extensive knowledge in circular design can lead workshops and seminars, offering deep insights and practical advice. **Experienced Colleagues**: Engineers who have successfully implemented circular design can share their experiences and lessons learned, providing relatable and credible examples.
Collaborative Goal Setting	Set or agree on a circular behavioural goal (e.g. applying guidelines from Leidraad Circulair to one design meticulously) and circular project goal (e.g. "deliver at least one design with five innovative circular design options each month.") in collaboration with the engineers, rather than merely on their behalf (BCT 1.1, 1.3).	1.1 Goal Setting (behavior) 1.3 Goal Setting (outcome)	**Live Content**: Goal-setting workshops and team meetings provide an interactive platform for engineers to discuss and establish clear goals. These sessions facilitate collaboration and ensure that all team members are aligned with the circular design objectives and provide feedback on achievable goals. **Print Media**: Manuals, guidelines, and goal-setting templates can be used to document and reference the agreed-upon goals. These materials ensure that the goals are clearly communicated and accessible to all team members.	**Team Leads**: By leading the goal-setting process, Team Leads ensure that the goals are embraced by the entire team, fostering a sense of ownership and commitment.

Focusing on Committed Clients	Prioritising design projects with clients committed to circular designs, who are open to higher-cost solutions or are discontent with traditional designs, thus providing more time, opportunity, open-mindedness, and support for making circular choices (BCT 7.4, 7.5).	7.4 Remove access to the reward 7.5 Remove aversive stimulus	**Face-to-face individual**: One-on-one meetings with clients to discuss the benefits and implementation strategies of circular design. These face-to-face interactions ensure that clients' needs and expectations are clearly understood and addressed. **Face-to-face group**: Interactive sessions where clients can engage with design teams to explore circular design solutions and their practical applications. **Print Media**: Educational promo materials for clients which contain case studies, success stories, and detailed explanations of circular design principles to reinforce understanding and support decision-making. Updates and news to provide engaged and committed clients with updates, project milestones and circular design integration and maintain circular engagement.	**Management**: Decide strategically to take on more circular projects from circular-minded clients in the market. **Circular Experts** and **Client Relationship Managers**: Organising circular client meetings and distributing promo materials. **Marketing and Communications Team**: create and distribute educational promo materials,
Building Expert Support Systems	Establish a helpdesk, expert team or information centre where engineers can get practical support for a variety of challenges and questions and which organises regular in-depth sessions with open invitation, addressing challenging cases in applying circular design methods (BCT 3.2, 6.1, 7.6, 7.7).	3.2 Social support (practical) 6.1 Demonstration of the behavior 7.6 Satiation 7.7 Exposure	**Live Content**: Regular Q&A sessions and support meetings offer real-time assistance and address engineers' questions and challenges. **Digital Applications**: Online helpdesk and support chat platforms provide convenient access to expert advice and resources. **Print Media**: Informational brochures and FAQs can provide quick reference materials for engineers.	**Helpdesk Staff**: Trained personnel available to provide immediate support and guidance. **Expert Team**: A group of experienced professionals available for consultation, ensuring that engineers have access to high-level expertise.
Integrating Circular Design Habits	Create habits and routine by adding several prompts/cues in the planning and process of projects to prompt circular	7.1 Prompts/cues 8.3 Habit formation 8.4 Habit reversal	**Signage**: Reminders and posts in the (online) workspace can prompt engineers to adopt circular design practices consistently. **Digital Applications**: Notifications and reminders integrated into project management tools can	**Management**: Facilitate the integration of prompts and cues, ensuring consistent reinforcement of circular design practices. **Project Managers**: Oversee the

	design and to replace traditional design (e.g. circular ambition and brainstorm meetings, document deliverables) (BCT 7.1, 8.3, 8.4).		reinforce circular design habits. **Live Content**: Regular team check-ins and planning meetings can help integrate circular design into the workflow.	implementation of habits and routines, ensuring that circular design becomes a standard practice.
Share Success Stories and Feedback	Showcase success stories or give instructive feedback by monitoring and reviewing behavioural goals, project goals and realisations of circular designs (BCT 1.5, 1.6, 2.1, 2.2, 2.5, 2.7). Showcase success stories or give instructive feedback by monitoring and reviewing behavioural goals, project goals and realisations of circular designs (BCT 1.5, 1.6, 2.1, 2.2, 2.5, 2.7).	1.5 Review Behavior Goal(s) 1.6 Discrepancy between current behavior and goal 2.1 Monitoring of behavior by others without feedback 2.2 Feedback on behavior 2.5 Monitoring outcome(s) of behavior by others without feedback 2.7 Feedback on outcome(s) of behavior	**Live Content**: Feedback sessions and review meetings provide opportunities for real-time discussion and reflection on progress. **Digital Media**: Newsletters and case study reports can highlight success stories, showcase successful implementations and provide detailed feedback on performance.	**Team Leads**: Provide regular feedback and monitor progress, ensuring that engineers stay on track with circular design goals. **Colleagues**: Share success stories and lessons learned, offering relatable and credible examples of circular design in practice. **Expert Team**: A group of experienced professionals who review projects and share identified common mistakes or missed opportunities.

Appendix H. BCTs

This appendix focuses on formulating interventions based on the BCW analysis. It lists Behavior Change Techniques (BCTs) and categorises them according to their relevance to the intervention functions and COM-B components, providing a strategic approach to enhancing circular design practices in engineering contexts.

BCT overview

Overview of 93 hierarchically-clustered Behaviour Change Techniques of Taxonomy version 1:

Goals and planning
1.1. Goal setting (behavior)
1.2. Problem solving
1.3. Goal setting (outcome)
1.4. Action planning
1.5. Review behavior goal(s)
1.6. Discrepancy between current behavior and goal
1.7. Review outcome goal(s)
1.8. Behavioral contract
1.9. Commitment

Feedback and monitoring
2.1. Monitoring of behavior by others without feedback
2.2. Feedback on behavior
2.3. Self-monitoring of behavior
2.4. Self-monitoring of outcome(s) of behavior
2.5. Monitoring of behavior without feedback
2.6. Biofeedback
2.7. Feedback on outcome(s) of behavior

Social support
3.1. Social support (unspecified)
3.2. Social support (practical)
3.3. Social support (emotional)

Shaping knowledge
4.1. Instruction on how to perform the behavior
4.2. Information about antecedents
4.3. Re-attribution
4.4. Behavioral experiments

Natural consequences
5.1. Information about health consequences
5.2. Salience of consequences
5.3. Information about social and environmental consequences
5.4. Monitoring of emotional consequences
5.5. Anticipated regret
5.6. Information about emotional consequences

Comparison of behavior
6.1. Demonstration of the behavior
6.2. Social comparison
6.3. Information about others' approval

Associations
7.1. Prompts/cues
7.2. Cue signaling reward
7.3. Reduce prompts/cues
7.4. Remove access to the reward
7.5. Remove aversive stimulus
7.6. Satiation
7.7. Exposure
7.8. Associative learning

Repetition and substitution
8.1. Behavioral practice/rehearsal
8.2. Behavior substitution

8.3. Habit formation
8.4. Habit reversal
8.5. Overcorrection
8.6. Generalization of target behavior
8.7. Graded tasks

Reward and threat
9.1. Material incentive (behavior)
9.2. Material reward (behavior)
9.3. Non-specific reward
9.4. Social reward
9.5. Non-specific incentive
9.6. Social incentive
9.7. Self-incentive
9.8. Incentive (outcome)
9.9. Reward (outcome)
9.10. Future punishment

BCT overview, filled in with case study example

The BCTs are evaluated on APEASE with a score on scale 1-5, depending on the high, medium or low score for an individual APEASE component

- Acceptability - Do people like it enough to use?
- Practicability - Is it easy to use?
- Effectiveness - Does it work in the real world?
- Affordability - Cheap?
- Side-effects - Is it safe? Does it cause harm?
- Equity - Decreasing inequalities?

The BCT table is ordered on APEASE score, and next on BCT number

Nr	Label	APEASE score	Definition of BCT	Case study example for BCT	Acceptability	Practicability	Effectiveness	Affordability	Side-effects	Equity
1.1	**Goal Setting (behaviour)**	5	Set or agree on a goal defined in terms of the behaviour to be achieved	Set concrete goals for implementing circular design methods, such as "Apply guidelines Leidraad CB 23 at the start of each project phase"	High	High	High	High	Low	High
1.4	**Action Planning**	5	Prompt detailed planning of performance of the behaviour	Make detailed plans for how and when the circular design methods will be applied. This can include setting specific deadlines and responsibilities.	High	High	High	High	Low	High
3.2	**Social support (practical)**	5	Advise on, arrange, or provide practical help for performance of the behaviour.	Provide practical help in executing circular design, such as access to resources, tools, and a helpdesk.	High	High	High	Medium	Low	High

4.1	**Instruction on how to perform a behaviour**	5	Advise or agree on how to perform the behaviour (includes 'Skills training')	Offer training and workshops on circular design methods, including practical skills.	High	High	Very High	Low	Low	High
8.3	**Habit formation**	5	Prompt rehearsal and repetition of the behaviour in the same context repeatedly so that the context elicits the behaviour	Repeat circular design methods regularly in the same context, such as kick-off meetings, so these methods become a fixed part of the process.	High	High	High	High	Low	High
8.4	**Habit reversal**	5	Prompt rehearsal and repetition of an alternative behaviour to replace an unwanted habitual behaviour	Replace unwanted default design routines with circular practices through intensive training sessions and regular repetition.	High	High	High	Medium	Low	High
8.7	**Graded tasks**	5	Set easy-to-perform tasks, making them increasingly difficult, but achievable, until behaviour is performed	Start with simple circular design tasks and gradually increase complexity as engineers become more familiar with the methods.	High	High	High	High	Low	High
1.2	**Problem Solving**	4	Analyse, or prompt the person to analyse, factors influencing the behaviour and generate or select strategies that include overcoming barriers and/or increasing facilitator	Analyze the factors influencing behaviour and generate strategies to overcome barriers and enhance facilitators.	High	Medium	High	Medium	Low	High
1.3	**Goal Setting (outcome)**	4	Set or agree on a goal defined in terms of a positive outcome of wanted behaviour	Set goals for positive outcomes of desired behaviour, such as "50% circularity in the next project" or "Make at least one design with five innovative circular design chocies each month."	High	Medium	Medium	Medium	Low	High
1.5	**Review behaviour Goal(s)**	4	Review behaviour goal(s) jointly with the person and consider modifying goal(s) or behaviour change strategy in light of achievement.	Discuss behaviour goals with engineers and consider adjustments to goals or behaviour change strategies.	High	High	Medium	Medium	Low	High
3.1	**Social support**	4	Advise on, arrange or provide social support or non- contingent praise or	Provide social support or non-contingent praise or rewards for performing circular design.	High	Medium	Medium	High	Low	High

	(unspecified)		reward for performance of the behaviour.							
5.3	**Information about social and environmental consequences**	4	Provide information (e.g. written, verbal, visual) about social and environmental consequences of performing the behaviour	Provide information about the social and environmental consequences of circular design, such as improved sustainability and reduced environmental impact.	High	High	Medium	High	Low	High
6.1	**Demonstration of the behaviour**	4	Provide an observable sample of the performance of the behaviour, directly in person or indirectly e.g. via film, pictures, for the person to aspire to or imitate	Demonstrate an example of applying circular design methods.	High	High	Medium	Medium	Low	High
7.1	**Prompts/cues**	4	Introduce or define environmental or social stimulus with the purpose of prompting or cueing the behaviour	Introduce or define environmental or social cues to prompt or stimulate circular design behaviour, such as agenda items on circularity.	High	High	Medium	Medium	Low	High
7.5	**Remove aversive stimulus**	4	Advise or arrange for the removal of an aversive stimulus to facilitate behaviour change (includes 'Escape learning')	Arrange for the removal of barriers or unpleasant conditions that hinder circular design, such as unrealistic client expectations or internal resistance.	High	Medium	Very High	Low	Low	High
7.6	**Satiation**	4	Advise or arrange repeated exposure to a stimulus that reduces or extinguishes a drive for the unwanted behaviour	Arrange repeated exposure to circular design methods and examples, so engineers become accustomed to this approach and the drive for traditional methods is reduced.	High	High	Medium	Low	Low	High
7.7	**Exposure**	4	Provide systematic confrontation with a feared stimulus to reduce the response to a later encounter	Ensure systematic confrontation with challenges of circular design, such as workshops discussing difficult cases to build confidence and skill.	High	High	High	Medium	Low	High

8.1	**behavioural practice/rehearsal**	4	Prompt practice or rehearsal of the performance of the behaviour one or more times in a context or at a time when the performance may not be necessary, in order to increase habit and skill	Practice the circular design process in simulated projects or training sessions, allowing engineers to improve their skills without the pressure of real projects.	High	High	High	Low	Low	High
8.6	**Generalisation of a target behaviour**	4	Advise to perform the wanted behaviour, which is already performed in a particular situation, in another situation	Advise engineers to apply circular design principles used in one project to other projects and contexts.	High	High	Medium	High	Low	High
9.1	**Credible source**	4	Present verbal or visual communication from a credible source in favour of or against the behaviour	Present information about circular design from a credible source, such as recognized experts or successful companies in the industry.	High	High	Medium	High	Low	High
9.2	**Pros and cons**	4	Advise the person to identify and compare reasons for wanting (pros) and not wanting to (cons) change the behaviour (includes 'Decisional balance')	Encourage engineers to identify and compare the pros and cons of circular design and discuss these considerations in team meetings.	High	High	Medium	Medium	Low	High
9.3	**Comparative imagining of future outcomes**	4	Prompt or advise the imagining and comparing of future outcomes of changed versus unchanged behaviour	Encourage engineers to compare possible outcomes of their designs with and without the application of circular methods.	High	High	Medium	Medium	Low	High
11.3	**Conserving mental resources**	4	Advise on ways of minimising demands on mental resources to facilitate behaviour change	Facilitate ways to minimize the need for mental resources, such as simplifying strategies by providing checklists to ease the execution of circular designs.	High	High	High	Medium	Low	High
12.2	**Restructuring the social**	4	Change, or advise to change the social environment in order to facilitate performance of the wanted behaviour	Change the social environment, for example, by promoting a culture that supports circular design through leadership and team dynamics.	High	Medium	High	Medium	Low	High

	environment		or create barriers to the unwanted behaviour							
15.2	**Mental rehearsal of successful performance**	4	Advise to practise imagining performing the behaviour successfully in relevant contexts	Have engineers practice successfully implementing circular design methods in relevant contexts, such as simulations or pilot projects.	High	High	Medium	Low	Low	High
1.6	**Discrepancy between current behaviour and goal**	3	Draw attention to discrepancies between a person's current behaviour and the person's previously set goals	Draw attention to discrepancies between current behaviour and previously set goals to create awareness.	Medium	High	Medium	Medium	Medium	High
2.1	**Monitoring of behaviour by others without feedback**	3	Observe or record behaviour with the person's knowledge as part of a behaviour change strategy	Observe or record behaviour with the engineer's knowledge as part of a behaviour change strategy.	Medium	Medium	Medium	Medium	Low	High
2.2	**Feedback on behaviour**	3	Monitor and provide informative or evaluative feedback on performance of the behaviour	Monitor and provide informative or evaluative feedback on the execution of the behaviour, such as monthly evaluations and discussions of progress.	Medium	High	Medium	Medium	Low	High
2.4	**Self-monitoring of outcome(s) of behaviour**	3	Establish a method for the person to monitor and record the outcome(s) of their behaviour as part of a behaviour change strategy	Establish a method for engineers to monitor and record the outcomes of their behaviour as part of a behaviour change strategy.	Medium	High	Medium	Medium	Low	High

2.5	**Monitoring outcome(s) of behaviour by others without feedback**	*3*	Observe or record outcomes of behaviour with the person's knowledge as part of a behaviour change strategy	Observe or record the outcomes of behaviour with the engineer's knowledge as part of a behaviour change strategy.	Medium	Medium	Medium	Medium	Low	High
2.7	**Feedback on outcome(s) of behaviour**	*3*	Monitor and provide feedback on the outcome of performance of the behaviour	Monitor and give feedback on the outcome of the behaviour execution.	Medium	Medium	Medium	High	Low	High
6.3	**Information about others' approval**	*3*	Provide information about what other people think about the behaviour	Provide information about what other people, such as managers or colleagues, think about circular design to increase social norms and pressure.	High	Medium	Medium	Medium	Low	High
7.4	**Remove access to the reward**	*3*	Advise or arrange for the person to be separated from situations in which unwanted behaviour can be rewarded in order to reduce the behaviour (includes 'Time out')	Arrange for engineers to be separated from situations in which unwanted behaviour is rewarded to stimulate circular design behaviour.	Medium	Medium	Medium	Medium	Low	High
7.8	**Associative learning**	*3*	Present a neutral stimulus jointly with a stimulus that already elicits the behaviour repeatedly until the neutral stimulus elicits that behaviour	Present success stories of circular design alongside weekly design discussions, so these examples become standard in the minds and practices of engineers.	Medium	Medium	Medium	Medium	Low	High
10.4	**Social reward**	*3*	Arrange verbal or non-verbal reward if and only if there has been effort and/or progress in performing the behaviour (includes 'Positive reinforcement')	Give verbal or non-verbal rewards, such as praise or recognition, to engineers who make progress in circular design.	High	Medium	Medium	High	Low	High

10.5	**Social incentive**	3	Inform that a verbal or non-verbal reward will be delivered if and only if there has been effort and/or progress in performing the behaviour (includes 'Positive reinforcement')	Inform engineers that they will receive verbal or non-verbal rewards if they show effort and/or progress in circular design.	High	Medium	Medium	High	Low	High
11.2	**Reduce negative emotions**	3	Advise on ways of reducing negative emotions to facilitate performance of the behaviour (includes 'Stress Management')	Advise on ways to reduce negative emotions, such as stress management techniques, to facilitate the execution of circular design.	Medium	Medium	Medium	Medium	Low	High
13.1	**Identification of self as role model**	3	Inform that one's own behaviour may be an example to others	Tell engineers that their behaviour can set an example for others, and encourage them to apply circular design methods to inspire their colleagues.	High	Medium	Medium	High	Low	High
13.2	**Framing/reframing**	3	Suggest the deliberate adoption of a perspective or new perspective on behaviour (e.g. its purpose) in order to change cognitions or emotions about performing the behaviour (includes 'Cognitive structuring')	Encourage engineers to adopt a new perspective on circular design by emphasizing its benefits and positive impact.	High	Medium	Medium	High	Low	High
13.3	**Incompatible beliefs**	3	Draw attention to discrepancies between current or past behaviour and self-image, in order to create discomfort (includes 'Cognitive dissonance')	Draw attention to discrepancies between current or past behaviour and the self-image of engineers to create discomfort and stimulate behaviour change.	Medium	Medium	Medium	High	Low	High
13.4	**Valued self-identity**	3	Advise the person to write or complete rating scales about a cherished value or personal strength as a means of affirming the person's identity as part of a behaviour change strategy (includes 'Self-affirmation')	Advise engineers to reflect on personal values and strengths and how circular design contributes to their professional identity and pride.	Medium	Medium	Medium	High	Low	High
15.1	**Verbal persuasion**	3	Tell the person that they can successfully perform the wanted behaviour, arguing against self-doubts	Tell engineers that they can successfully apply circular design methods and encourage them to overcome their doubts.	Medium	Medium	Medium	High	Low	High

	about capability		and asserting that they can and will succeed							
15.3	**Focus on past success**	3	Advise to think about or list previous successes in performing the behaviour (or parts of it)	Advise engineers to reflect on past successes in implementing circular design and list these to increase self-confidence.	Medium	Medium	Medium	High	Low	High
1.7	**Review Outcome Goal(s)**	2	Review outcome goal(s) jointly with the person and consider modifying goal(s) in light of achievement.	Discuss outcome goals with engineers and consider adjustments to goals in light of achieved results.	Medium	High	Low	High	Low	High
1.9	**Commitment**	2	Ask the person to affirm or reaffirm statements indicating commitment to change the behaviour	Ask the engineer to affirm or reaffirm statements indicating their determination to change behaviour.	Medium	Medium	Low	High	Low	High
2.3	**Self-monitoring of behaviour**	2	Establish a method for the person to monitor and record their behaviour(s) as part of a behaviour change strategy	Encourage engineers to keep track of their progress regarding the application of circular design methods.	Low	High	Low	High	Low	High
4.2	**Information about antecedents**	2	Provide information about antecedents (e.g. social and environmental situations and events, emotions, cognitions) that reliably predict performance of the behaviour	Provide information about situations, events, emotions, and cognitions that predict and influence the execution of circular design.	High	Medium	Low	High	Low	High
4.3	**Re-attribution**	2	Elicit perceived causes of behaviour and suggest alternative explanations	Discover perceived causes of behaviour and suggest alternative explanations to correct misunderstandings about circular design.	Medium	Medium	Medium	High	Low	High
4.4	**behavioural experiments**	2	Advise on how to identify and test hypotheses about the behaviour, its causes and consequences, by collecting and interpreting data	Advise engineers on how to test hypotheses about circular design with data collection and interpretation.	Medium	Medium	Medium	High	Low	High
5.2	**Salience of consequences**	2	Use methods specifically designed to emphasise the consequences of performing the behaviour with the aim of making them more memorable	Use methods to emphasize the negative consequences of not using circular design so that engineers better remember and consider these.	Low	Medium	Low	Medium	Low	High

5.4	**Monitoring of emotional consequences**	**2**	Prompt assessment of feelings after attempts at performing the behaviour	Regularly evaluate the feelings and emotions of engineers after attempts to design circularly to identify and address emotional barriers.	Low	Medium	Medium	High	Low	High
5.5	**Anticipated regret**	**2**	Induce or raise awareness of expectations of future regret about performance of the unwanted behaviour	Raise awareness of expected future regret about not applying circular design.	Low	Medium	Low	High	Low	High
5.6	**Information about emotional consequences**	**2**	Provide information (e.g. written, verbal, visual) about emotional consequences of performing the behaviour	Provide information about the emotional benefits of circular design, such as pride and satisfaction from sustainable contributions.	Medium	High	Low	High	Low	High
6.2	**Social comparison**	**2**	Draw attention to others' performance to allow comparison with the person's own performance	Draw attention to the achievements of others to allow comparison with the engineers' own performance.	Medium	Low	Medium	Medium	Low	High
7.3	**Reduce prompts/cues**	**2**	Withdraw gradually prompts to perform the behaviour (includes 'Fading')	Gradually withdraw the cues to perform circular design behaviour (including 'Fading').	High	Medium	Low	Medium	Low	High
8.2	**behaviour substitution**	**2**	Prompt substitution of the unwanted behaviour with a wanted or neutral behaviour	Encourage engineers to directly replace traditional design methods with circular methods in their daily work.	Medium	Low	Low	High	Low	High
10.1	**Material incentive (behaviour)**	**2**	Inform that money, vouchers or other valued objects will be delivered if and only if there has been effort and/or progress in performing the behaviour (includes 'Positive reinforcement')	Inform engineers that money, vouchers, or other valuable items will be given if effort and/or progress is made in applying circular design methods.	Low	Medium	Low	Medium	Low	High

10.2	**Material reward (behaviour)**	2	Arrange for the delivery of money, vouchers or other valued objects if and only if there has been effort and/or progress in performing the behaviour (includes 'Positive reinforcement')	Ensure the delivery of money, vouchers, or other valuable items as a reward for effort and/or progress in circular design.	Medium	Medium	Low	Medium	Low	High
10.6	**Non-specific incentive**	2	Inform that a reward will be delivered if and only if there has been effort and/or progress in performing the behaviour (includes 'Positive reinforcement')	Inform engineers that there will be a reward for effort and/or progress in circular design, without specific performance criteria.	Medium	Low	Medium	Medium	Low	High
10.7	**Self-incentive**	2	Plan to reward self in future if and only if there has been effort and/or progress in performing the behaviour	Encourage engineers to reward themselves in the future if they have shown effort and/or progress in applying circular design methods.	Medium	Low	Medium	Medium	Low	High
10.8	**Incentive (outcome)**	2	Inform that a reward will be delivered if and only if there has been effort and/or progress in achieving the behavioural outcome (includes 'Positive reinforcement')	Inform engineers that they will receive a reward if they have shown effort and/or progress in achieving circular design milestones.	Medium	Low	Medium	Medium	Low	High
10.9	**Self-reward**	2	Prompt self-praise or self-reward if and only if there has been effort and/or progress in performing the behaviour	Encourage engineers to give themselves praise or rewards if they have shown effort and/or progress in applying circular design methods.	Medium	Medium	Low	High	Low	High
10.10	**Reward (outcome)**	2	Arrange for the delivery of a reward if and only if there has been effort and/or progress in achieving the behavioural outcome (includes 'Positive reinforcement')	Provide a reward for engineers if they show effort and/or progress in achieving circular design milestones.	Medium	Low	Medium	Medium	Low	High
12.1	**Restructuring the physical**	2	Change, or advise to change the physical environment in order to facilitate performance of the wanted behaviour or create barriers to the unwanted behaviour	Change or advise on changing the physical environment, such as designing workspaces that facilitate the use of circular materials.	Medium	Medium	Medium	Medium	Low	High

	environment									
12.4	**Distraction**	2	Advise or arrange to use an alternative focus for attention to avoid triggers for unwanted behaviour	Advise or arrange an alternative focus of attention to prevent triggers for unwanted behaviour, such as offering workshops on circular design during busy periods.	Medium	Medium	Medium	Medium	Low	High
12.5	**Adding objects to the environment**	2	Add objects to the environment in order to facilitate performance of the behaviour	Add objects to the work environment that facilitate the execution of circular design, such as recycled materials and tools.	High	Medium	Low	Medium	Low	High
13.5	**Identity associated with changed behaviour**	2	Advise the person to construct a new self-identity as someone who 'used to engage with the unwanted behaviour'	Advise engineers to develop a new professional identity centered around circular design.	Medium	Low	Medium	High	Low	High
14.4	**Reward approximation**	2	Arrange for reward following any approximation to the target behaviour, gradually rewarding only performance closer to the wanted behaviour (includes 'Shaping')	Arrange a reward after each approach to the desired behaviour, such as steps towards implementing circular design methods.	Low	Low	Low	Low	Low	High
14.5	**Rewarding completion**	2	Build up behaviour by arranging reward following final component of the behaviour; gradually add the components of the behaviour that occur earlier in the behavioural sequence (includes 'Backward chaining')	Build behaviour by arranging a reward after completing each phase of the circular design process, such as after finishing the lifecycle analysis.	Medium	Medium	Low	Medium	Low	High

14.7	**Reward incompatible behaviour**	2	Arrange reward for responding in a manner that is incompatible with a previous response to that situation (includes 'Counter-conditioning')	Arrange a reward for behaviour that is incompatible with unwanted behaviour, such as choosing circular materials over conventional options.	Medium	Medium	Low	Low	Low	High
14.8	**Reward alternative behaviour**	2	Arrange reward for performance of an alternative to the unwanted behaviour (includes 'Differential reinforcement')	Arrange a reward for performing an alternative to unwanted behaviour, such as using circular design tools instead of traditional methods.	Medium	Medium	Low	Low	Low	High
15.4	**Self-talk**	2	Prompt positive self-talk (aloud or silently) before and during the behaviour	Encourage engineers to use positive self-talk (aloud or silently) before and during the application of circular design methods.	Low	Medium	Low	High	Low	High
1.8	**behavioural contract**	1	Create a written specification of the behaviour to be performed, agreed on by the person, and witnessed by another	Make a written specification of the behaviour to be performed that the engineer agrees with and a witness attests to.	Low	Medium	Low	High	Low	High
2.6	**Biofeedback**	1	Provide feedback about the body (e.g. physiological or biochemical state) using an external monitoring device as part of a behaviour change strategy	Give feedback about the body (e.g., physiological or biochemical state) using an external monitoring device as part of a behaviour change strategy.	Low	Low	Low	Low	Medium	Low
3.3	**Social support (emotional)**	1	Advise on, arrange, or provide emotional social support for performance of the behaviour.	Advise and provide emotional support for performing circular design, such as motivational conversations and support in facing challenges.	Low	Low	Low	High	Low	High
5.1	**Information about health consequences**	1	Provide information (e.g. written, verbal, visual) about health consequences of performing the behaviour	Provide information about the health consequences of applying circular design, such as reducing harmful emissions.	Low	Low	Low	Medium	Low	High
7.2	**Cue signalling reward**	1	Identify an environmental stimulus that reliably predicts that reward will follow the behaviour	Identify an environmental stimulus that reliably predicts that reward will follow circular design behaviour.	Low	Low	Low	Low	Low	High

8.5	**Overcorrection**	1	Ask to repeat the wanted behaviour in an exaggerated way following an unwanted behaviour	Ask engineers to excessively repeat circular design principles after using traditional methods to reinforce the new approach.	Low	Medium	Low	Medium	Low	High
10.3	**Non-specific reward**	1	Arrange delivery of a reward if and only if there has been effort and/or progress in performing the behaviour (includes 'Positive reinforcement')	Provide a reward if engineers show effort and/or progress in circular design, without specific performance criteria.	Low	Low	Low	Medium	Low	High
10.11	**Future punishment**	1	Inform that future punishment or removal of reward will be a consequence of performance of an unwanted behaviour (may include fear arousal) (includes 'Threat')	Inform engineers that there will be sanctions or removal of rewards in the future if they exhibit unwanted behaviour, such as not applying circular design methods.	Low	Medium	Medium	Medium	High	Medium
11.1	**Pharmacological support**	1	Provide, or encourage the use of or adherence to, drugs to facilitate behaviour change	Offer or encourage the use or adherence to medications to facilitate behaviour change.	Low	Low	Low	Low	High	Low
11.4	**Paradoxical instructions**	1	Advise to engage in some form of the unwanted behaviour with the aim of reducing motivation to engage in that behaviour	Advise engineers to engage in unwanted behaviour to reduce their motivation to exhibit that behaviour, such as recording unnecessary waste.	Low	Low	Low	Low	High	Medium
12.3	**Avoidance/reducing exposure to cues for the behaviour**	1	Advise on how to avoid exposure to specific social and contextual/physical cues for the behaviour, including changing daily or weekly routines	Advise engineers to avoid exposure to specific cues that promote unwanted behaviour, such as changing routines that lead to waste.	Low	Low	Low	High	Low	High
12.6	**Body changes**	1	Alter body structure, functioning or support directly to facilitate behaviour change	Directly change the body structure, function, or support to facilitate behaviour change, such as ergonomic tools for circular design.	Low	Low	Low	Low	High	Low

14.1	**behaviour cost**	1	Arrange for withdrawal of something valued if and only if an unwanted behaviour is performed (includes 'Response cost')	Ensure the withdrawal of something valuable, such as a bonus or recognition, if engineers exhibit unwanted behaviour, such as ignoring circular design methods.	Low	Low	Low	Medium	High	High
14.2	**Punishment**	1	Arrange for aversive consequence contingent on the performance of the unwanted behaviour	Provide aversive consequences, such as negative feedback or extra work, depending on the exhibition of unwanted behaviour.	Low	Low	Low	Medium	High	Low
14.3	**Remove reward**	1	Arrange for discontinuation of contingent reward following performance of the unwanted behaviour (includes 'Extinction')	Stop giving rewards after the exhibition of unwanted behaviour, such as not applying circular design methods.	Low	Low	Low	Medium	High	High
14.6	**Situation-specific reward**	1	Arrange for reward following the behaviour in one situation but not in another (includes 'Discrimination training')	Arrange rewards for circular design behaviour in specific situations, but not others, to promote behaviour differentiation.	Low	Medium	Low	Low	Low	High
14.9	**Reduce reward frequency**	1	Arrange for rewards to be made contingent on increasing duration or frequency of the behaviour (includes 'Thinning')	Ensure that rewards depend on the increasing duration or frequency of the circular design process, such as monthly recognition for consistent behaviour.	Medium	Low	Low	Medium	Low	High
14.10	**Remove punishment**	1	Arrange for removal of an unpleasant consequence contingent on performance of the wanted behaviour (includes 'Negative reinforcement')	Ensure the removal of an unpleasant consequence, such as negative feedback, that depends on the execution of circular design behaviour (including 'negative reinforcement').	Low	Low	Low	High	High	High
16.1	**Imaginary punishment**	1	Advise to imagine performing the unwanted behaviour in a real-life situation followed by imagining an unpleasant consequence (includes 'Covert sensitisation')	Advise engineers to imagine engaging in unwanted behaviour and its negative consequences to increase their motivation for circular design.	Low	Low	Low	High	Medium	High
16.2	**Imaginary reward**	1	Advise to imagine performing the wanted behaviour in a real-life situation followed by imagining a	Advise engineers to imagine successfully exhibiting circular design behaviour and its positive consequences to increase their motivation.	Low	Low	Low	High	Low	High

			pleasant consequence (includes 'Covert conditioning')							
16.3	**Vicarious consequences**	**1**	Prompt observation of the consequences (including rewards and punishments) for others when they perform the behaviour	Let engineers observe the consequences for others (including rewards and punishments) when they exhibit or do not exhibit circular design behaviour.	Medium	Medium	Low	Medium	Medium	Medium

BCT Categorised in Intervention Functions

The categorization of high-scoring Behavior Change Techniques (BCT) is contingent upon the interpretation and application of the BCT itself. In certain cases, a BCT may only provide minimal or indirect support to specific intervention functions, but is not completely unrelated to these functions. To enhance clarity in understanding the relationship between BCTs and intervention functions, only the most apparent connections were established.

BCT with (APEASE score ≥3)	Education	Persuasion	Incentivisation	Coercion	Training	Restriction	Environmental Restructuring	Modeling	Enablement
1.1 Goal Setting (behavior)			✓						✓
1.4 Action Planning	✓				✓				✓
3.2 Social support (practical)									✓
4.1 Instruction on how to perform	✓				✓				
8.3 Habit formation							✓		
8.4 Habit reversal					✓		✓		
8.7 Graded tasks					✓				
9.1 Credible source	✓	✓							
1.2 Problem Solving	✓								✓
1.3 Goal Setting (outcome)			✓						✓
1.5 Review behavior Goal(s)									✓
3.1 Social support (unspecified)			✓						
5.3 Information about social and environmental consequences	✓	✓							
6.1 Demonstration of the behavior								✓	
7.1 Prompts/cues							✓		
7.5 Remove aversive stimulus						✓			
7.6 Satiation						✓			
7.7 Exposure							✓		
8.1 Behavioral practice/rehearsal					✓				
8.6 Generalization of a target behavior									✓
9.2 Pros and cons	✓	✓							

9.3 Comparative imagining of future outcomes		✓							
11.3 Conserving mental resources							✓		
12.2 Restructuring the social environment							✓		
15.2 Mental rehearsal of successful performance					✓				
1.6 Discrepancy between current behaviour and goal	✓								✓
2.1 Monitoring of behaviour by others without feedback									✓
2.2 Feedback on behaviour	✓								✓
2.4 Self-monitoring of outcome(s) of behaviour									✓
2.5 Monitoring outcome(s) of behaviour by others without feedback									✓
2.7 Feedback on outcome(s) of behaviour	✓								✓
6.3 Information about others' approval		✓							
7.4 Remove access to the reward				✓		✓			
7.8 Associative learning					✓				✓
10.4 Social reward			✓						
10.5 Social incentive			✓						
11.2 Reduce negative emotions		✓							
13.1 Identification of self as role model		✓						✓	
13.2 Framing/reframing	✓	✓							
13.3 Incompatible beliefs	✓								
13.4 Valued self-identity		✓							
15.1 Verbal persuasion about capability		✓							
15.3 Focus on past success		✓							

BCT Categorised in Policy Categories

The categorization of Behavior Change Techniques (BCT) is contingent upon the interpretation and application of the BCT itself. In certain cases, a BCT may have minimal or indirect link to a policy category, but is not completely unrelated to the category. To enhance clarity in understanding the relationship between BCTs and policy categories, only the most apparent connections were established.

BCT with (APEASE score ≥3)	Communication/ Marketing	Guidelines	Fiscal Measures	Regulation	Legislation	Environmental/Social Planning	Service Provision
1.1 Goal Setting (behavior)	✓	✓					✓
1.4 Action Planning	✓	✓					✓
3.2 Social support (practical)	✓						✓
4.1 Instruction on how to perform	✓	✓					✓
8.3 Habit formation	✓					✓	
8.4 Habit reversal	✓					✓	
8.7 Graded tasks	✓						
9.1 Credible source	✓						
1.2 Problem Solving	✓	✓					
1.3 Goal Setting (outcome)	✓	✓					✓
1.5 Review behavior Goal(s)	✓	✓					✓
3.1 Social support (unspecified)	✓						✓
5.3 Information about social and environmental consequences	✓					✓	
6.1 Demonstration of the behavior	✓						
7.1 Prompts/cues	✓					✓	
7.5 Remove aversive stimulus				✓	✓		
7.6 Satiation				✓	✓		
7.7 Exposure	✓					✓	
8.1 Behavioral practice/rehearsal	✓						✓
8.6 Generalization of a target behavior	✓						✓

9.2 Pros and cons	✓						
9.3 Comparative imagining of future outcomes	✓						
11.3 Conserving mental resources	✓					✓	
12.2 Restructuring the social environment						✓	
15.2 Mental rehearsal of successful performance	✓						
1.6 Discrepancy between current behaviour and goal	✓	✓					
2.1 Monitoring of behaviour by others without feedback	✓						✓
2.2 Feedback on behaviour	✓						✓
2.4 Self-monitoring of outcome(s) of behaviour	✓						✓
2.5 Monitoring outcome(s) of behaviour by others without feedback	✓						✓
2.7 Feedback on outcome(s) of behaviour	✓						✓
6.3 Information about others' approval	✓						
7.4 Remove access to the reward				✓	✓		
7.8 Associative learning						✓	
10.4 Social reward	✓		✓				
10.5 Social incentive	✓		✓				
11.2 Reduce negative emotions	✓						
13.1 Identification of self as role model	✓						
13.2 Framing/reframing	✓						
13.3 Incompatible beliefs	✓						
13.4 Valued self-identity	✓						
15.1 Verbal persuasion about capability	✓						
15.3 Focus on past success	✓						