Master Thesis Report

Towards Acceleration of Re-Use Transition in the Infrastructure Sector

A practical framework for public client organizations to link the tactical level to the operational level in implementing the re-use strategy

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Delft University of Technology

Towards Acceleration of Re-Use Transition in the Infrastructure Sector

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In partial fulfillment of the requirements for the degree of **Master of Science in Construction Management and Engineering** at **Delft University of Technology**

In Collaboration with the **Municipality of Den Haag**

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Declaration of Authorship

I, Negar Aboutalebi, declaring that this thesis report is completely my own work, unless something else revealed. I know the TU Delft rules on plagiarism check, and its prospect consequences. I have not put this report on any other repository for getting degree from other institution.

Preface

This thesis research titled: *'Towards acceleration of re-use transition in the infrastructure sector'* is provided as final stage of study program; Mater of Science in Construction Management and Engineering (CME) at Delft University of Technology. During the period of providing this thesis research, I faced many challenges, however, with my passion to this study program and the topic of circularity, which is my field of interest, I could keep myself motivated and continue until the end of this journey. Working on this multi-phase project with novel approach of re-use within the context of a public client organization, not only developed my scientific skills but also my personality and professional skills.

I was not alone in this journey and I had this opportunity to do my graduation project under the supervision of a professional graduation committee. I really appreciate all the time and efforts that this committee dedicated on my research process, and I want to express my sincere to all the 5 members of this committee. First and in specific, thanks to my first supervisor, Dr. Maedeh Molaei, who dedicated lots of time on my project. Thank you for your patience and your attempts to help me in the complex stages of my research. You always shared your novel ideas and useful hints with me. Secondly, thanks to the chair of the committee, Prof.Dr.ir Marcel Hertogh. Thank you for your nice guidance in my project, helping with finding the best research topic and always motivating me with your compliments. Also, thanks to Dr. Yirang Lim, who always guided me with her nice comments on the methodology and structure of the report, which really enhanced the quality of my work. Thanks to my organization first supervisor, Ir. Wilco Verkade for dedicating lots of time on my project. Thank you for always being there for my questions and guiding me from professional point of view. Also, thanks to my second organization supervisor; Ir. Lennart Kerpel, who not only guided me through the thesis research, but also learned me the way of working in context of a professional atmosphere, and showed me how to deal with challenges.

I want to appreciate the opportunity that Municipality of Den Haag provided for me, and let me to do my research in the context of this organization. Thanks to all managers who dedicated lots of time and patience on evaluating the result of my research. Also, Thanks to all 18 participants in the semi-structured interview phase of the research who provided valuable data for this study.

Finally, thanks to my family who were miles far away from me, but always supported me and motivated me in this journey. Lastly, a special thanks for my husband ***Mohammad Javad*** who truly walked me through this path and always motivated me with his love and support. You were my strength and without you I could not pass this journey!

Thank you all and this achievement was not possible without you!

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Executive Summary

The existing high level of greenhouse emissions and raw material consumption within the construction activities are the current concern in this industry, in which the infrastructure sector has the highest share. On the other hand, the programs of renovating the aged and overloaded infrastructures are currently under progress as substantial national programs with circularity targets in the Dutch context, involving various public-private networks like the 'Infra5daagse'[1]. Implementing circularity strategies in conducting the infrastructure projects will be highly beneficial to reduce the amount of emissions, minimize the raw material consumption and facilitate the formulated national programs. Specifically, reaching these targets can be possible through implementation of specific circularity strategy of re-use which is innovative and has the highest value among all circularity strategies. Currently, there are just few prototype projects around the Netherlands; constructed using the re-use strategy (Boweconomie, 2022; Noord-Holland, 2019). Running higher number of these projects and accelerating the re-use transition in the infrastructure sector are urgent topics in the global and Dutch context, which needs following specific organizational procedures (Boweconomie, 2022; Government of the Netherlands, 2018; Oppen, Croon, & De Vroe, 2018). Public client organizations (PCOs) have determining role in conducting and accelerating the re-use transition in the infrastructure sector, as owner and commissioner of infrastructure projects.
The problem which is tried to be solved within this research is formulated as follows:

- **Problem statement**

Development of circular infrastructures with material re-use strategy, requires integration of a wider network with more interactions, and implementation of extra stages which make these projects very complicated, and make the organizational aspects in these projects extremely important (Oppen, Croon, & De Vroe, 2018). Complex and unique organizational specifications in re-use projects create barriers for development of these projects in the infrastructure sector (Oppen, Croon, & De Vroe, 2018). As a result of these barriers, most attempts are locked at the tactical level of PCOs, and a gap is emerged between the tactical and operational level of these organizations in implementation of re-use strategy. This gap prevents the transition towards circular infrastructure projects with material re-use strategy, to be accelerated at operational level of the PCOs. This gap is zoomed and investigated in detail in this research. Public clients require specific organizational procedures to deal with this gap, and accelerate the re-use transition in the infrastructure sector.

- **Research objective and the main research question**

To find a solution for the stated problem, the main research objective defined as providing specific organizational procedures for public client organizations in format of a practical framework, to follow to link the organizational levels and accelerate implementation of re-use strategy at operational level of these organizations. This objective followed through reaching 4 sub-objectives:1.Collecting the enablers and barriers for implementing re-use projects and common re-use implementation factors from theoretical sources 2.Identifying existing gaps in practice between the tactical and operational levels of public client organizations, in implementation of re-use strategy 3.Linking relevant important gaps, enablers and barriers. 4. Formulating a framework including required procedures for filling the gaps between the tactical and operational levels of PCOs. The main question which formulated to reach these objectives, is as follows:

[1] Infra5daagse is a network which is organized in 2022, to reach the targets of national programs of renovating infrastructures, using the innovative and circular approaches https://www.toekomst-infra.org/cloud-solutions

MRQ: How can the implementation of the circular infrastructure projects with material re-use strategy be accelerated at the operational level of the public client organizations?

This research is conducted within the Municipality of Den Haag as a public client organization which has a large share in infrastructure renovation programs, and is involved in the network of Infra5daagse. Only the organizational gaps are investigated in the scope of this research. At the end, organizational procedures formulated within the recommended framework as final solution.

- **Research Methodology**

The research is conducted through a qualitative method, and by following three different phases of theoretical study, empirical study and solution development. In the theoretical phase, a list of enablers and barriers for implementing circular infrastructure projects with re-use strategy gathered from literatures. Also, common circularity implementation factors and sub-factors (re-use specific factors) gathered through conducting a synthesis method on existing circularity frameworks, to use in solution development phase. From a document review in the empirical study phase, links and distinctions among tactical and operational level in implementing re-use strategy have been investigated and a list of gaps in practice identified. Then, through a round of semi-structured interviews with practitioners, the important gaps verified and prioritized. Also, within the same stage, the list of enablers and barriers gathered from literatures prioritized through a survey, and added to the ones collected from interviewees responses to the open questions. The important enablers and barriers, shortlisted to the most relevant ones for dealing with the important gaps and together with gathered recommendations from practitioners considered as input for formulating the framework. Finally, required procedures to fill the top gaps formulated using the gathered circularity implementation sub-factors and recommendations, and suggested to the public client organizations in the format of a framework to accelerate the re-use transition. Results gathered under 8 categories (from literature review phase) in all stages of research, to make linking them together easier in development of the final framework.

- **Provision of the final framework**

Formulating a framework for public client organizations to accelerate implementation of circular infrastructure projects with re-use strategy was the aim of this study. This framework provided including the organizational procedures, recommended to be followed by actors within specific levels of operational, tactical and tactical& operational, to fill the identified gaps between them in short-term and long-term. In the provided framework, specific fields of interventions required for filling the top gaps defined and labeled by their relevant categories. Within each category, one relevant circularity implementation factor considered to address the gap in that category. The implementation factors are prioritized based on prioritization of gaps, and recognized as *re-use implementation factors* in the preliminary framework. Formulated procedures, defined relevant to each of these factors in the framework. Each procedure can be followed to implement the enablers, and overcome the barriers in a specific filed of gap, to finally fill that. In the expert evaluation stage, through conducting a brainstorming session, it decided to only focus on the top 3 gaps which are more fundamental and more urgent to be filled, and relevant procedures to them have been validated. The final framework addresses the gaps under two categories of *culture, communication and behavior* and *contract, manuals and guidelines* using the 3 re-use implementation factors of:

- *Development of re-use targets, technical/organizational follow-ups & evaluations on them*
- *Structuring internal/external communications for re-use*
- *Structuring collaborations with external parties for re-use*

Strategic level was not in the scope of this research, however, involvement of this level found required for formulating and re-visioning the re-use targets. The formulated framework is illustrated in the Figure 1.

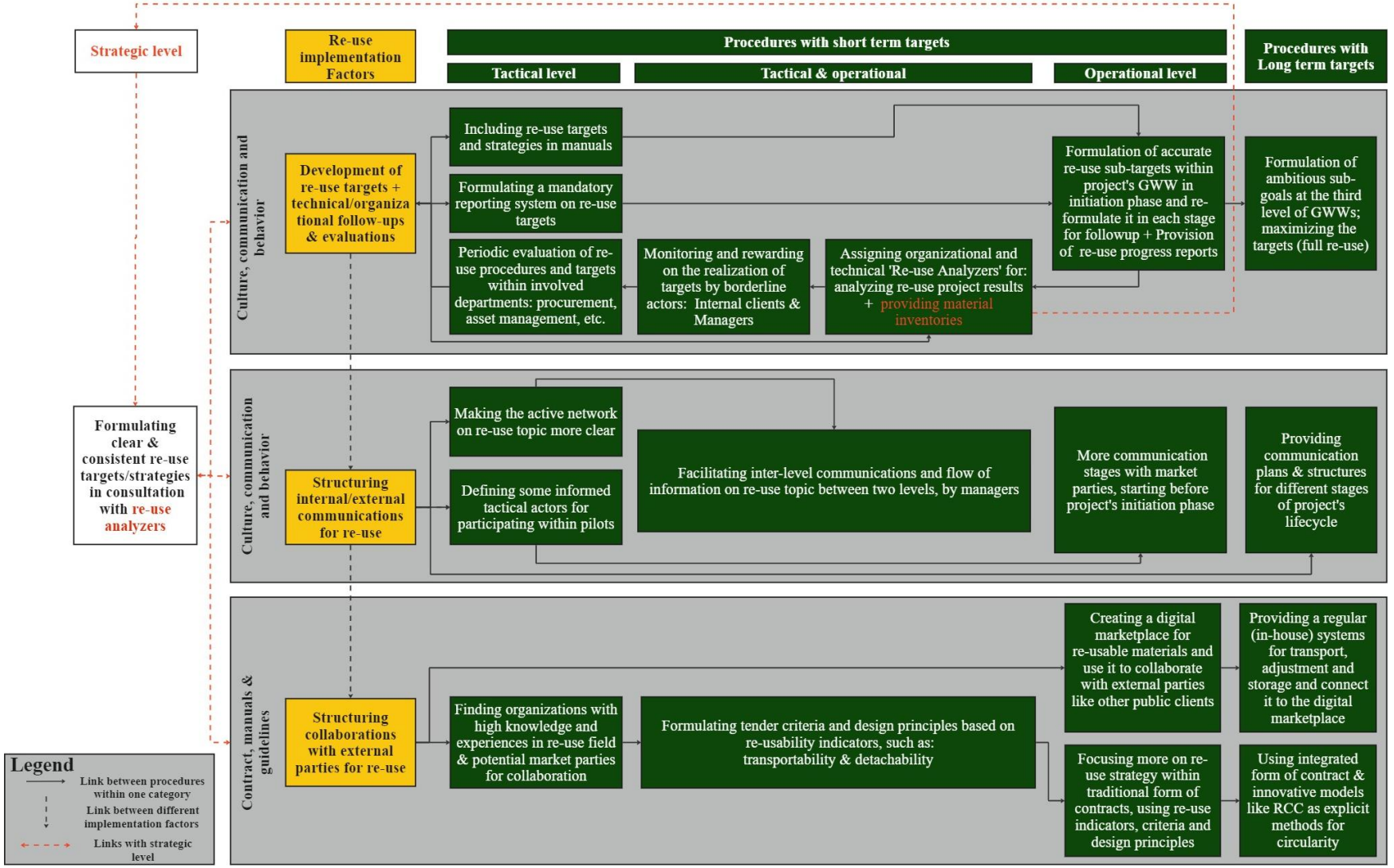

Figure 1: Organizational framework for accelerating implementation of circular infrastructure projects with re-use strategy at operational level of the public client organizations

- **Highlights on the provided framework and conclusion**

The recommended procedures in the formulated framework are interrelated, which means result of implementing number of procedures should be followed by work of actors in the same or another level. This framework is multi-level and should put into practice by all actors in all 3 levels of tactical, operational and strategic, and also actors in the borderline of tactical & operational level. To implement the framework, managers in each organizational level can formulate specific advisory documents and re-formulate the suggested procedures for each level, into detailed tasks for the relevant actors. In most cases, implementation of short-term and long-term targets are interrelated as well, and experience with implementing the short-term targets can reveal the necessity of following the procedures which should be developed in the long-term. Moreover, for implementing procedures with long-term target, dedication of more resources are required. Hence, managers in tactical and strategic level can analyze the result at the end of implementing the short-term targets and see if developing the long-term targets and provision of required new resources for them are still required.

To make the two levels of tactical and operational connected, intervention of the strategic level is also required, specifically for formulating and re-visioning the targets. There is also a link between the three re-use implementation factors in the framework. After *developing the targets and evaluations*, the *communications* should first be structured, and then the *external collaborations* can be enabled. Structuring the *communications, collaborations and target formulation stages* through implementing the procedures recommended in the presented framework and consistency with that, will prepare the organizational context for conducting more re-use activities and link the tactical and operational level in implementing re-use projects. As a result, the re-use activities at the operational level of the public client organizations will be more structured in implementing the re-use strategy. With well-linked tactical and operational level, and structured activities at operational level, the re-use transition will be facilitated and more circular infrastructure projects can be implemented with re-use strategy at operational level of the public client organizations. Hence the implementation of circular infrastructure projects with material re-use strategy and re-use transition can be accelerated at operational level of the public client organizations.

Currently, in the existing studies, there is less attention to the re-use transition in the infrastrcuture sector and role of public clients in that, hence, this research provides valuable findings for practice and scientific works in the field of re-use transition in this sector. This research study added into the theoretical body of knowledge, in the field of re-use transition, and addressed how to accelerate this transition specifically in the infrastrcuture sector for the first time. One significance of the presented framework in this study is its detailed and interrelated procedures which fomulated for each specific level of the organization (strategic,tactical & operational). Moreover, the suggested organizational procedures in the presented framework for dealing with the identified gaps, are not only based on the academic resources, but also the experiences of practitioners with re-use projects, which are less addressed within the existing studies.

To accelerate the implementation of circular infrastructure projects with material re-use strategy, some recommendations are formulated on top of the presented framework, for the municipality of Den Haag, other public clients, the Infra5daagse network, and also the future researchers which are presented below:

- **Recommendations to the Municipality of Den Haag**

It is recommended to the cluster mangers in the IBDH (the main operational department), to add the suggested framework in this research into the '*Sustainable Commissioning Program',* in consultation with tactical actors responsible for this program from other departments (e.g. DBV, DSO), within the

Sustainability Knowledge Team of the organization. The sustainable commissioning program and the recommended framework in this research can complement each other to connect the tactical and operational level in re-use transition within this organization. The integrated version of these two frameworks can also be generalized and used for reaching other sustainability and circularity targets within the municipality.

It is recommended to the IBDH to start with assigning the re-use analyzers, to be able to provide the required material inventories and concentrate on target formulation with tactical and strategic actors. Then, the reporting system should be cleared in consultation with tactical actors, to enable both target formulation and reporting procedure, defined in the sustainable commissioning program. It is also recommended to the IBDH to train in-house re-use analyzers after gaining enough experience in working with external analyzers. The short-term and long-term targets within the presented framework can be defined considering the shared millstones between the network of 'infra 5 daagse' and the Dutch national circularity program (2030 and 2050). Also, it is recommended to the tactical & strategic departments of the municipality to: Customize the framework based on the resources and common procedures within the municipality, dedicate a test period for the framework within the organization to see the level of effectiveness of that, check where are the exact gaps in implementation of other sustainability themes or circularity strategies, and customize the presented framework for filling the identified gaps.

- **Recommendations to PCOs and Infra5daagse Network**

It is recommended to the other public client organizations to identify their internal gaps in implementing re-use projects, and then implement compatible parts of the presented framework to address and fill that gaps. Also, to address a circular solution for the national programs of renovating infrastructures, it is highly suggested to the active networks in them, like 'Infra5daagse' to consider the network as the national context for re-use transition, and customize the framework to structure the inter-organizational procedures between the involved parties. Through structuring collaborations & communications between tactical and operational parties, developing clear and detailed targets and evaluating them, the re-use transition can also be accelerated in the national scale.

- **Recommendations for future scientific works**

Future researchers can conduct their studies on technical fields and try to develop more efficient and effective technical solutions for operational level of the transition, to re-use materials in the infrastructure projects. Also, since implementation of re-use strategy involves different parties in the market, such as contractors and suppliers of reclaimed materials. Investigating role of market parties and inter-organizational gaps in development of re-use projects, is also highly recommended to the future researchers. In this research optimal quantitative methods for conducting the analysis on targets have not been identified. Exploring optimal quantitative methods for doing analysis on result of re-use projects can also be another topic for future researches in this field. Moreover, this research only investigated the re-use activities at tactical and operational transition level of PCOs. Exploring strategic level of these organizations and trying to add a reflective level, is also recommended. Lastly, this research only addressed implementation of the circularity strategy of re-use, which has higher value. It is recommended to the future researchers to investigate other circularity strategies such as recycle, refurbish, etc. in development of the circular infrastructure projects with no possibility of re-use, by addressing the pros and cons of each strategy.

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List of Abbreviations & Specific Terms

DSB	Department of City Management
DSO	Department of Urban Development
DBV	Department of Operations
DPZ	Department of Public Services
OCW	Culture and Welfare Department
SZW	Social Affairs Department
MKI	Material Cost Indicator
HOR	Handbook of Public Places
RCC	Rapid Circular Contracting Procurement
GWW	Sustainability Ambition Web
CDW	Construction, Demolition & Waste
DFD	Design for Detachability
IPM	Integrated Project Management
BIM	Building Information Management System
PO	Public Organization
PCO	Public Client Organization
LCA	Life Cycle Analysis
IBDH	Engineering Firm of the Municipality of Den Haag
Rijkswaterstaat	Netherland's Ministry of Infrastructure and Water Management

Chapter 1:

Introduction

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CHAPTER1: INTRODUCTION

This chapter is aimed to introduce the research. In the section 1.1, a general background of research is represented, followed by introducing the case organization in the section 1.2. The investigated problem is elaborated in the section 1.3. The research gap and research objectives are presented in the sections 1.4 and 1.5 respectively. In the section 1.6 the scope of research is mentioned. The main research question and sub-questions which have been answered in this research are presented in the section 1.7. The research methodology is explained in the section 1.8. Lastly, section 1.9 indicates the research outline.

1.1. Research Background

Reducing the "amount of greenhouse emission by 2050", defined within the "Paris Agreement" as a critical global target, and can be reached through following the "pathway of Circular Economy" in different sectors (UNDP, 2023). According to the formulated "European Circular Economy Agenda" (Government of the Netherlands, 2018), the two sub-sectors of *Built environment* and *Infrastructure* within the construction industry (Afshari & Gorecki, 2019) have crucial roles in reaching the global "Net-Zero" target (Union, 2021). The construction industry, has the highest share in production of greenhouse gas (more than 53% share), in which the infrastructure sector has the largest part (Boweconomie, 2022). Currently, there is also an increasing concern regarding the inadequate amount of raw materials, comparing to the increasing number of population, which can also be solved following the "circular economy pathway" (UNDP, 2023). Recent publications revealed the fact that, the infrastructure industry is also responsible for consuming "more than 60 percent of raw martials" (Boweconomie, 2022; UNDP, 2023). The built environment sector, was successful in reducing the amount of raw material consumption to high extent, by use of second hand materials or 'material re-use' (FCRBE, 2021). Conducting circualr projects, by implementing strategy of re-use, can also be highly effective in deducting "the amount of raw material consumption"and production of green house gas in the infrastructure sector (Boweconomie, 2022).

Concerns regarding the incremental demand for raw materials & environmental impacts of that are even more bold in the Dutch context, and made the governments to set the target of being "fully circular by 2050" as well (Government, 2021). In line with this target, various national programs of "renovating and replacing aged and overloaded infrastructures" which dates back to 1960', are under progress as part of the circularity transition (Infra, 2021). In these programs, various parties are cooperating in the context of public, private & scientific networks like; 'Infra5daagse' (Infra, 2021), which is organized in 2022 including more than 30 parties (Infra, 2021), to reach the targets of these programs, using the innovative and circular approaches like re-use (Government, 2021). Currently, just few prototype projects around the Netherlands are constructed by re-use method (Boweconomie, 2022; Noord-Holland, 2019). Accelerating the re-use transition in the infrastructure sector is the current concern of public clients in the Dutch context, which needs specific organizational considerations and procedures (Government of the Netherlands, 2018; Oppen, Croon, & De Vroe, 2018).

1.2. Case Municipality of Den Haag

Infrastructures are owned and commissioned by the public client organizations (Geerts, Ghyoot, & Naval, 2020), which have determining role in conducting the re-use transition and accelerating that (Loorbach, 2010). This research is conducted within the context of the Municipality of Den Haag, which is one of the important public client organizations in the Netherlands. Den Haag is one of the 4 big cities within the Netherlands (The Hague in numbers , 2023). The reason of choosing the municipality of Den Haag, is that

it has a large share in infrastructure renovation programs, and is involved in the network of Infra5daagse. This organization currently has general targets at its strategic level for integrating the sustainability approaches more into practice, and "make the city fully green", with one important sub-goals of making infrastructure sector fully circular (The Hague , 2018). This public client organization is divided into different departments with various responsibilities and all expertise in-house, such as commissioning, managing, and operating the infrastructures (The Municipal Organziation , 2023). Conducting this research within the context of the municipality of Den Haag, facilitated investigating the implementation of re-use practices, and gaps in that field from different point of views.

1.3. Problem statement

Development of circular infrastructures with material re-use strategy, requires integration of a wider network with more transactions, and implementation of extra stages which make these projects very complicated, and make the organizational aspects in these projects extremely important (Oppen, Croon, & De Vroe, 2018). To prevent the complexities to be critical in conducting re-use projects, public clients as project "owners and commissioners" have determining role (Geerts, Ghyoot, & Naval, 2020). Current work procedures (way of collaboration, communication, etc.) which are followed in infrastructure projects, are not compatible with unique organizational characteristics of re-use projects (Oppen, Croon, & De Vroe, 2018). The unique organizational charcateristics in re-use projects caused some barriers for public client organizations. For instance, other than *wider network of actors* in the re-use projects, which cause complicated collaborations (FCRBE, 2018), the supply chain is also wider in these projects, and implies on "higher transactions and higher transactional costs" (Kanters, 2022). Moreover, need for definite re-use ambitions, might make the initiation phase of projects a bit hectic (Noord-Holland, 2019). Specifically, in infrastructure projects, existence of unique public values makes a need for innovative form of contracts and unique award criteria, which are more complicated to procure (FCRBE, 2018). The barriers for implementing re-use strategy, also recognized in the conducted priliminary dicussion with the case organization of Municipality of Den Haag. Caused barriers, prevent public client organizations to develop high number of circular infrastructure projects with re-use strategy, and make the re-use transition accelerated. Number of projects which are conducting in this organization with re-use method is very low and most attempts are locked at the tactical level of this organization. Hence, there is a gap between the operational level and tactical level of the public client organizations in implimenting circualr infrastructure projects with re-use strategy. This gap, will be zoomed and investigated in detail in this research. Public clients require to create detailed plans, specific organizational procedures and practical frameworks (Infra, 2021) to deal with this gap. Using such framework and plans will be very helpful in conducting multi-actor re-use projects and will make it easier to share knowledge and experiences among involved parties in them (Infra, 2021). Required organizational procedures to fill that will be formulated in the format of a practical framework for the Municpality of Den Haag.

1.4 Research Gap

Until now many researches are conducted on investigation of benefits and urgency of integrating circularity strategies in construction projects, specifically within the infrastructure sector (Boweconomie, 2022). As result of these researches prototype projects have been conducted with re-use strategy (Noord-Holland, 2019), which have not continued to higher number of projects at operational level of public organizations (Rijkswaterstaat, 2023). There is less attention in the current studies to the existing gaps in practices in conducting re-use projects in the infrastructure sector (Boweconomie, 2022; FCRBE, 2021), required procedures to fill these gaps and accelerating the re-use transition. There is a scientific gap in linking the operational and tactical level (Boweconomie, 2022; Mendoza et all., 2018) of public client organizations in

implementing re-use strategy, which is concentrated in this research. Creation of such link will help to accelerate the implementation of re-use strategy at operational level of public client organizations and construction of higher number of re-use projects.

1.5 Research Objective

To implement the re-use strategy in the infrastructure projects, the three factors of "actors, materials and policies" should be considered and connected properly (FCRBE, 2021). Hence there is an extreme need to zoom into each organization level of public client organizations and investigate the link between these three factors, in implementation of re-use projects. For instance, availability of second hand and re-usable materials, concrete connections between actors and provision of required policies for working with such materials should be facilitated by organizations. Formulating specific organizational procedures for re-use within the both tactical & operational levels and between them, will be helpful to make a more concrete connection between "actors, policies and use of reclaimed materials" (FCRBE, 2021). This research is aimed to formulate such organizational procedures, and following them will help to accelerate the implementation of re-use strategy at operational level of the public client organizations.

1.6. Research scope

Working on circularity domain in infrastructure sector with specific approach of re-use needs zooming into different technical and organizational aspects. The main focus of this research is organizational aspects which are more fundamental in facilitating the technical solutions for implementing re-use strategy in the future. However, since all "three factors of actors, materials and policies" should be connected in implementation of re-use projects (FCRBE, 2021), technical aspects relevant to availability and supply of materials are also explored in this research. The research is done completely within the scope of Municipality of Den Haag, and internal work procedures and relation between actors within the municipality are investigated in terms of implementation of re-use strategy (Op de Woert, 2013). In fields like supply of reclaimed materials, and type of contracts in re-use projects, the collaborations between the municipality and market parties are also investigated.

1.7. Research question & Sub-questions

The main research question (MRQ) in this research is formulated as follows:

MRQ: How can the implementation of the circular infrastructure projects with material re-use approach be accelerated at the operational level of the public client organizations?

The MRQ is aimed to be answered at the end of this research through formulation of a framework for public client organizations to help them to implement more infrastructure projects with circular strategy of re-use in the future. To reach the answer of the formulated MRQ, 5 sub-research questions (SRQs) have been formulated to be answered in different scientific and empirical stages of the research. These SRQs are:

SRQ1: What are the enablers and barriers for implementation of circular infrastructure projects with materials re-use strategy within the public client organizations?

This sub-question is formulated to be answered in the literature review phase, and build the required theoretical base of the research. Answering this research question, contributed to provision of a list of enablers and barriers in different categories. This list used as one main input for the empirical study phase.

SRQ2: What are the potential organizational factors for implementing circular projects with re-use strategy?

This sub-question is formulated to provide a list of organizational factors which can facilitate the implementation of circular infrastructure projects with re-use strategy within the operational level of the public organizations. List of these factors used as one of the main components of the final framework.

SRQ3: How does the current procedures and guidelines at the tactical level for implementing circular strategy of re-use relate to the practices at the operational level?

This question is formulated to evaluate the current situation with implementation of circular strategy of re-use in practice, within the context of the public client organizations. To answer this sub-question, the re-use practices at operational level and procedures and guidelines at tactical level, have been reviewed and compared. As result of answering this question, a list of existing gaps in practice have been identified in different categories to be prioritized in the interview phase.

SRQ4: What enablers and barriers can be identified to deal with the important gaps between tactical and operational level in implementing re-use projects?

This question has been formulated with aim of linking the most urgent gaps in practice with the relevant enablers and barriers for dealing with them, which were all prioritized by practitioners in the interview phase. This list was also one of the important components in provision of the final framework.

SRQ5: What procedures should be followed to fill the gaps between tactical and operational level in implementing re-use projects?

This question was formulated to address the main outputs of the research which were a framework for implementing more circular infrastructure projects with re-use strategy. The main part of this framework includes the procedures that suggested to follow by each organizational level. These procedures provided for the case Municipality of Den Haag, and other public client organizations to fill the most fundamental gaps between tactical and operational level in implementing the re-use strategy.

1.8. Research Methodology

The quality of outcome is not the only criteria for measuring the quality level of a research, and the way it designed is also a determining factor to attribute high quality to that research (Congdon & Dunham, 2006). A “high quality research design”, which is fit for answering the “research questions”, can assure the consistency of research through all formulated stages, and also quality of the provided “solution” (Pawar, 2020). Since the prospect result of this research is a “practical framework” as a solution for filling the gap in field of implementing re-use infrastructure projects, conducting “an applied research with a qualitative method” is the best option (Pawar, 2020). In this research study, only qualitative method of gathering and analyzing data is used, and few experiences with re-use method within the context of the municipality of Den Haag is investigated through semi-structured interviews (Pawar, 2020). In designing the methodology of this qualitative research, “5 main stages” are considered in general, including: “gathering the required data, analyzing them, providing the final solution and evaluate the final outcome” (Creswell, 2014). These 5 stages are performed in 3 main phases, which are explained in the next sub-section.

1.8.1. Research Methodology

To answer the formulated SRQs, 3 main phases are followed using specific methods in this research, which are formulated as follows:

a. Phase1- Theoretical Study; Literature review

In the first phase of this research, through conducting a round of literature reviews, theoretical bases for the concept of circular infrastructure projects with material re-use strategy have been provided. Fundamental concepts have been investigated in this phase such as: circularity, circularity in construction, circular infrastructures, re-use strategy, organizational structure of public client organizations, and transition levels. The gathered information from this phase explained within the literature review chapter. The aim of this phase was answering the SRQ1 and SRQ2. For answering the SRQ1, a list of enablers and barriers for implementing circular infrastructure projects with material re-use strategy required to be provided. This list is provided through conducting "Research Synthesis" method, which implies on integrating the commonalities between different lists of enablers and barriers in the fields relevant to the topic (Cooper & Hedges , 2009). For answering the SRQ2, the useful circularity implementation factors for re-use practices gathered through conducting another synthesis procedure on 9 circularity frameworks in different sectors. For finding required literatures, key words relevant to the topic searched in the sources such as: Science Direct, Research Gate, Academia, and TU Delft repository. Different journals reviewed in this phase such as: international journal of Project Management, International Journal of Policy, Administration and Institutions, Journal of Cleaner production, Waste Management, Journal of Environmental Management, and Journal of Resources Conservation and Recycling.

b. Phase 2- Empirical study; Document review and semi-structured interviews

This phase conducted in two consecutive steps of 'Document review' and 'Semi-structured interviews' to gather information from practice regarding current situation with implementation of re-use projects in infrastructure sector. The document review phase conducted with the aim of answering the SRQ3. In this step, the relevant documents to re-use practices in both tactical level and operational level of the Municipality of Den Haag have been reviewed and compared with each other. The result of this comparison is list of the existing fields of gap between tactical and operational level of the municipality in implementing re-use strategy. The list of gaps has been presented in the document review chapter of this research. To verify and prioritize the identified gaps and prevent subjectivity problem in gap identification process, a round of semi-structured interviews conducted with 18 practitioners as well. Also, to shortlist the enablers and barriers gathered in the literature review stage, this list checked and prioritized by interviewees, as well. As result of the semi-structured interview stage the final list of enablers and barriers, linked to the identified most important gaps to answer the SRQ4. Also, another result gathered from analyzing the interviews was a list of recommendations for linking the tactical and operational level and accelerating implementation of re-use projects.

c. Phase 3- Final solution development

This phase which includes provision of the preliminary framework and expert evaluation stage, aimed to answer the SRQ5. Within the framework formulation stage, required procedures to overcome the barriers and implement the enablers have been gathered from recommendations provided by interviewees and implementation factors obtained from literature reviews. These procedures suggested to each relevant organizational level, with specific targets of long-term and short-term, in a format of a preliminary framework. The formulated preliminary framework presented for experts within the municipality of Den Haag to evaluate the practicality of recommended procedures within the context of the municipality. The final framework provided based on the expert comments. The final framework formulated with aim of filling only the top 3 gaps, with more detailed structure and indication of the links between levels in filling each gap, which was asked by municipality experts.

Finalizing the research:

The final phase of the research includes provision of the 'research discussion and limitation' chapter, and the 'conclusion and recommendations' chapter. In the discussion stage the provided research and gathered results compared to the existing literatures, and strength points of research have been addressed. At the end of the same chapter, limitations of this research have been addressed, as well. In the conclusion chapter, the solution for accelerating the implementation of circular infrastructure projects with material re-use strategy or accelerating the re-use transition, have been elaborated based on the formulated framework. In this stage answers of all the SRQs and the MRQ are formulated, which followed by providing some recommendations for the municipality of Den Haag. Also, some recommendations for other public client organizations and future studies in field of implementing circular infrastructures with re-use strategy, have been formulated.

1.9. Thesis outline

After provision of the background & research method in this chapter (introduction), the **First phase** of the research is conducted as a *Theoretical study* through a literature review method (chapter 2). The results from literature reviews provide the theoretical bases for research and represent as answers of the SRQ1&2, including: a list of enablers and barriers for implementing circular infrastructure projects with material re-use strategy, and a list of implementation factors for re-use projects. **Phase 2** includes two empirical stages of document review and semi-structured interviews (represented in the chapter 3&4) to gather information on current situation with re-use transition in practice. The list of gaps among tactical and operational level in field of implementing re-use strategy have been identified, in the document review stage, followed by verifying, clarifying and prioritizing the gaps through semi-structured interviews. The list of enablers and barriers gathered from literatures also shortlisted through conducting a survey in the semi-structured interviews stage, and linked to the prioritized gaps. Also recommendations provided by interviewees, used as input for developing the preliminary framework in **Phase 3** (chapter 5). In this phase, using the list of implementation factors and interviewees recommendations, the required procedures formulated and final framework structured and verified in two consecutive expert evaluation sessions. Based on expert ideas, the final framework provided for the top 3 gaps in practice. In **Finalizing phase** of the research, the chapter 6 is provided, including discussion on gathered results and elaboration of research limitations. Also in same phase, research conclusion (chapter 7) is provided in which answer of all sub-questions, main question and recommendations for practice and prospect studies are formulated. The outline of this research is represented in the Figure 1.1.

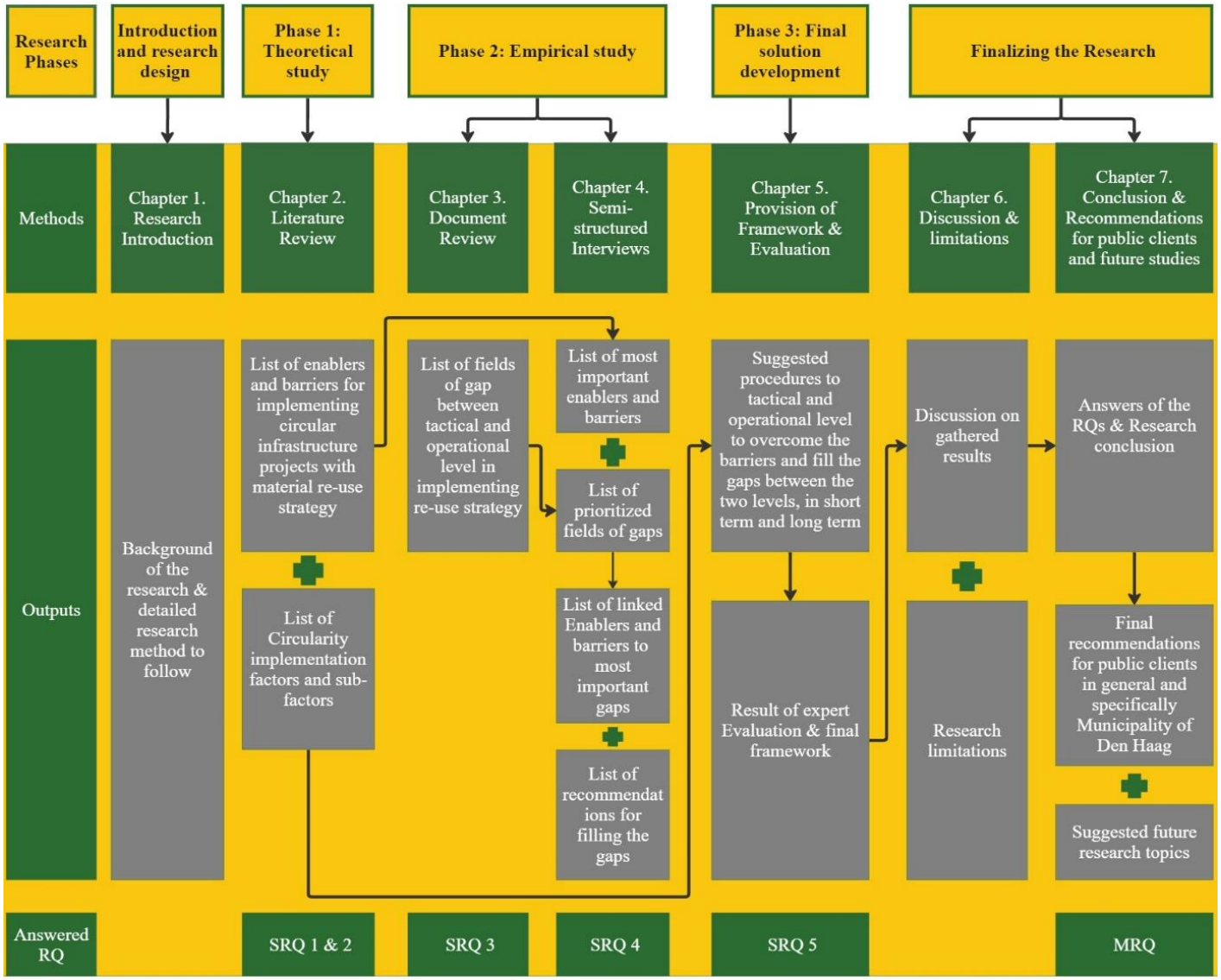

Figure 1.1. Illustration of the Thesis Outline

Chapter 2:

Literature Review

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CHAPTER2: LITERATURE REVIEW

In this section the main aim is investigating existing scientific resources in the field of circularity and re-use of materials in specific, to provide the answers of the two following sub-questions:

SRQ1: What are the enablers and barriers of the implementation of circular infrastructure projects with materials re-use strategy within public the client organizations?

SRQ2: What are the potential organizational factors for implementing circular projects with re-use strategy?

In this regard, first the general approach of circularity & circularity in the infrastructure sector is investigated in the section 2.1. Section 2.2. is focused on the re-use strategy in the infrastructure sector. Development of infrastructure projects with re-use strategy within the public client organizations is explored in the section 2.3. The enablers and barriers for implementing circular projects with re-use strategy are investigated in the section 2.4. In the section 2.5. various existing circularity frameworks have been reviewed with aim of gathering the circularity implementation factors fit for re-use target. Lastly, the chapter 2.6. includes the conclusion and the next steps of the research.

2.1. Circularity & Circular infrastructures

The "United Nations General Assembly" request from Norway "in 1983", can be defined as the starting point for discussing the Circular Economy (CE) theory, as one of the main subordinates of formulated sustainability transition targets (Valavanidis, 2018). Implementation of different strategies within the theory of circular economy into practice, is known as "circularity" (Coenen,2019). Circularity is also defined as a substantial pathway in realization of the "Paris agreement zero emission targets", which is expected to reduce the amount of emissions, by higher than 50 percent (Justenhoven & Lange-Snijders, 2019). Realization of "circularity and zero emission targets", is tied to make a "systematic change" in the existing "traditional work procedures" and make all activities circular within sectors (Coenen, 2019). Current "work procedures" within and between companies and organizations are "linear", which can cause high extent of raw material consumption and waste of resources, and should be turned into "closed loop procedures" (Coenen, 2019; Valavanidis, 2018). Global concerns regarding remained low amount of resources, made the implementation of circularity approach even more urgent in recent years (Rios , Grau , & Bilec, 2021). These concerns led to various attempts in different sectors, specifically within European and Dutch context, and mainly in the construction industry (Valavanidis, 2018). In the path towards being fully circular by 2050 (Leffers, Moustafa, & Vorstman, 2022) in the construction sector, still higher amount of efforts are required which should be more concentrated. In the next sub-section, circular construction & infrastructure projects, and important areas and strategies within these projects are elaborated.

2.1.1. Circular construction & infrastructure projects

Circular constructions are projects which consist of implementation of circularity strategies and solutions in their different stages with aim of reaching the "Circular Economy (CE) targets" (Coenen, Visscher , & Volker , 2022). Conducted studies in recent years revealed the fact that "the most important targets" in construction of circular projects are: lowering energy, material consumption & waste production levels, substituting artificial materials with bio-based and providing greener construction supply chains (Norouzi et al., 2021). Among all mentioned targets "controlling the amount of material consumption" and waste production, can be defined as the most significant ones in conducting circular construction projects (Ababio

& Lu, 2022; Caldera , Ryley, & Zatyko, 2020; Coenen, Visscher, & Volker, 2022; Justenhoven & Lange-Snijders, 2019; Rios, Grau, & Bilec, 2021). This target should be followed in different stages of project's lifecycle (Afshari & Gorecki, 2019). In achieving this target, gaining knowledge on "material lifecycle", and trying to maximize the material's lifespan through implementing circularity principles and strategies, are very crucial (Afshari & Gorecki, 2019). Construction industry is divided into 4 different sectors, and among them the infrastructure sector is one significant one with various specifications and sensitivities (Afshari & Gorecki, 2019), which will be higher by implementation of circularity strategies.

Circular infrastructures are projects that facilitate reaching the "(CE) targets", with decreasing the material consumption amount all over the project's lifecycle, using different circularity strategies (Global Infrastructure Hub, 2023). These strategies should be integrated within all activities in different stages of project's lifecycle, and all activities should be checked constantly in terms of compatibility with addressed circularity targets (Eisenreich, Fuller, & Stuchtey , 2021). Different stages in infrastructure project's lifecycle are indicated in the Figure 2.1, adopted based on the provided model by Dimitriou, Dean, & Ward, (2016). This model addresses 8 stages for projects. Circularity targets should be considered in each of this 8 stages. For instance, the first stage or "*project conception"*, includes investigation of project's context, discussing the lessons from previous experiences, and identification of important ambitions, including the circularity targets (Dimitriou, Dean, & Ward, 2016). Hence integration of circularity targets and strategies should be started from this stage, and should be continued by formulation of detailed targets, criteria, and task division on targets in the "*planning phase"* (Dimitriou, Dean, & Ward, 2016). Consequently, the circularity targets should be implemented in *"implementation"*, and *"operation"* stages and formulation and realization of these targets should be evaluated in the stages of *"pre-evaluation"*, *"monitoring stage"* and *"post evaluation"* (Dimitriou, Dean, & Ward, 2016). Final decisions should also be taken in *"closedown stage"* of projects, by analyzing level of circularity of final result (Dimitriou, Dean, & Ward, 2016). For evaluating and decision making in projects with more innovative strategies including circularity, engaging all project actors and stakeholders between project stages is more beneficial according to Bakker & De Kleijn, (2018) . These collaborative evaluation stages are indicated as *"circularity review points"* in the Figure 2.1. as well.

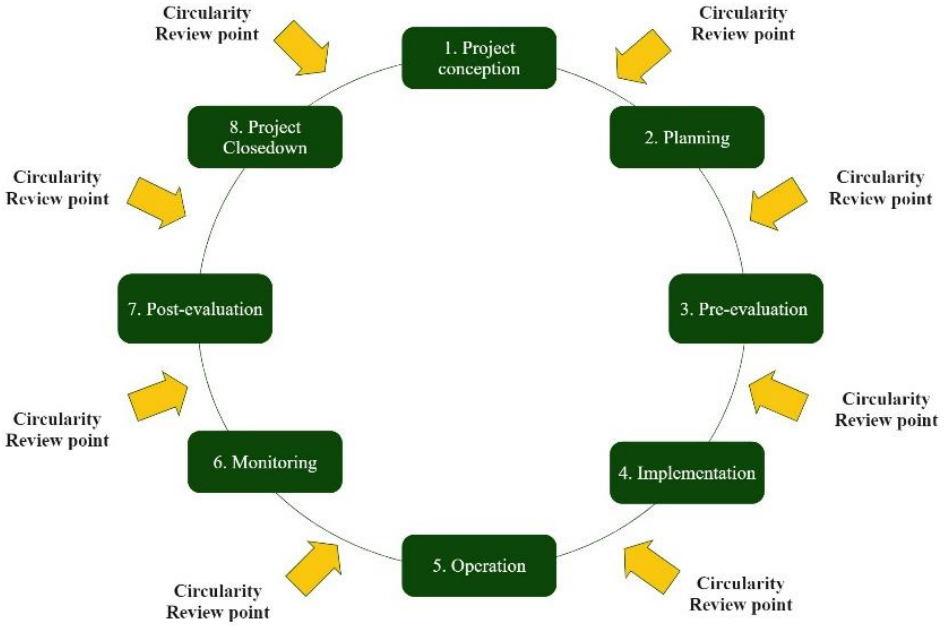

Figure 2.1: The infrastructure project's lifecycle for integrating circularity targets (Adopted from: Dimitriou, Dean, & Ward, 2016, P:17; Bakker & De Kleijn, 2018, P:12).

2.1.2. Circularity strategies for minimizing the material consumption

To reach the target of minimizing amount of material consumption, main strategies have been defined as circular strategies and known as "10 Rs" (Vermeulen, Witjes, & Reike, 2019) in all sectors. These strategies are depicted in the Figure 2.2, combined with its specific hierarchy. In the "hierarchy of 10Rs", higher level of efficiency, value creation, effectiveness in minimizing the resource exploitation and material consumption amount is on the top of hierarchy (R0) (Vermeulen, Witjes, & Reike, 2019). To implement each of these strategies certain expertise and actors are required to be involved in the projects (Oppen, Croon, & De Vroe, 2018; Vermeulen, Witjes, & Reike, 2019).

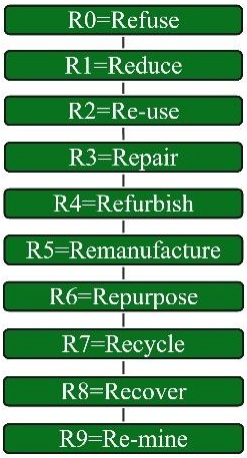

Figure 2.2: "The Hierarchy of 10Rs", (Adopted from: Vermeulen, Witjes, & Reike, (2019)).

The two first strategies suggested within the 10R framework (R0&R1) are "Refusing" the high level of material consumption and "Reducing" its level within projects, which are both highly valued and implying on a cultural attempt (Ekins, et al., 2019). However, the strategy R2 which is "Re-use", suggests a more solution oriented and innovative method (Ekins, et al., 2019), which can be better put into practice and still extract higher value from project result, comparing to recycle and other strategies (Anastasiades, Blom, Buyle, & Audenaert, 2020). In the next section the highly valued strategy of Re-use is elaborated in general and within the infrastructure sector.

2.2. Material re-use strategy and re-use in the infrastructure sector

Re-use by definition within the construction industry implies on using again the intact materials or components gathered from previous projects, in the previous projects or in a new one(Franco, Ludovico Almeida , & Calili, 2021) . Hence, re-implementing a used material or component in construction projects is the re-use activity as well, which can be either "site-to-site or on-site" (Geerts, Ghyoot, & Naval, 2020). This activity in general can bring higher value for project teams, specifically in the case of infrastructure projects can be very beneficial for "public clients" since they are also the owner of the infrastructure projects (Geerts, Ghyoot, & Naval, 2020). Different specifications of projects should be considered and investigated in the initial stages of circular infrastructure projects, namely the "reusability" and "recyclability" of project's materials (Coenen, 2019). Due to higher value of re-usability in the "*circularity strategy hierarchy"*, this aspect should be focused more, combined by considering its mutual relations with other important project targets (Anastasiades et al., 2020). One example of these relations is that; implementing re-use in the infrastructures can have positive influence on the environment, cost savings, and safeguarding

the ancient materials in the projects (Geerts, Ghyoot, & Naval, 2020). Relation between the “Lifecycle costs” and implimenting re-use strategy is also crucial and in some cases is a determining fcator in the decision making stages (Coenen, 2019). Based on experiences in implimenting re-use projects, there are 3 important procedures which should be followed in these projects (Topalov et al., 2021). These procedures are; recognition of the re-use experts active in the project’s region, identification of “re-use potentials” in the existing projects within the area, and following specific paths to impliment the re-usable materials in the new projects (Topalov et al., 2021). Identification of “re-use potentials” itself can be conducted through use of existing “material inventories” which is known as “checking the commenly re-usable materials by anology” (Deweerdt & Mertens, 2020). However, since currently there are not many available lists of re-usable mateirals from infrastructure projects, so it is suggested to project teams in this sector to learn and conduct the material analysis procedures or “relemation audiths” (Deweerdt & Mertens, 2020). To conduct these analysis, the respondible actors should formulate some criteria to check the materials based on them namely; Level of material’s quality, monitory value, dismantability, quantity, strenght, and “durability” (Deweerdt & Mertens, 2020). The current situation with implimenting re-use projects within infrastructure sector is explained in the next sub-sections.

2.2.1. Current situation of implementing re-use strategy within the infrastructure sector

The circularity strategy of re-use is an innovative method within the infrastructure sector, and can be recognized as a “Technological innovation system” (Hekkert et al., 2011). To analyze the situation with any technological “innovation system” it is required to address the exact “phase of development” of that innovation, which implies on the “level of diffusion of innovation” in the context, in each specific “period of time” (Hekkert, et al., 2011). As it is indicated in the Figure 2.3. there are 5 different development phases for each "innovation system”, and each of them can be known as “current development phase” if there is a positive answer to the question formulated before that phase (Hekkert et al., 2011). The re-use innovation in the infrastructure sector is currently in the “Take off” phase, since they are only few prototypes of these projects, but many efforts are in progress in the market to implement higher number of these projects (Hekkert et al., 2011). These efforts are more in the form of “pilot projects”, which are main requirements to leave the “take-off phase” and reach “the acceleration phase”, where high number of such innovative projects can easily be implemented (Hekkert et al., 2011). Specifically, in the infrastructure filed, the “pilots or the test projects” should be implemented in the both paths of “extracting materials from projects” and re-using them (Topalov et al., 2021). The development phases of the re-use innovation in the infrastructure sector is also highlighted in the Figure 2.3.

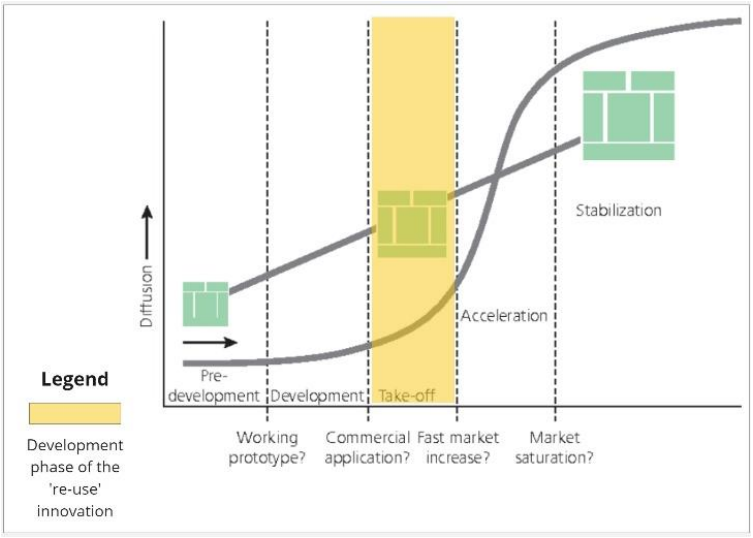

Figure 2.3. Illustration of the re-use "innovation development phases" in the infrastructure sector (Adopted form: Hekkert et al., 2011, P:9)

Moving towards acceleration of re-use innovation can be recognized as an important transition procedure, since an important pre-requisite of this acceleration is formulating a "systematic change" in implementation of projects (Ciliberto et al., 2021). Creation of this" systematic change" and conducting such transition can be extremely complex (Ciliberto et al., 2021). To conduct the re-use transition in the infrastructure sector, public clients have determining role, since they can enable the required circularity activities and stimulate market parties to be involved in such projects (Endo, 2022). Infrastructures are owned by public client organizations (Geerts, Ghyoot, & Naval, 2020), and they conduct transitions within this sector and manage the relevant complexities (Loorbach, 2010). In the next section, development of re-use projects within the public client organizations is elaborated, looking into their different organizational & transition levels.

2.3. Development of circular infrastructure projects with re-use strategy, within the public client organizations

In the path toward implementing strategy of re-use within the infrastructure projects, public client organizations "(PCOs)", require to implement an "intra-organizational systematic changes", and revise their organizational procedures (Endo, 2022; Philipp et al., 2022). For this huge revision, on top of reformulating the "strategies at strategic level", the organizational "structures" and connections between actors in "operational and tactical level" also should be revised (Philipp et al., 2022). These changes can be very challenging, and should be implemented through analyzing different levels within a specific plan with "long term vision" to be able to identify and overcome the possible complexities (Loorbach, 2010). This specific plan and long term vision can be structured based on the "Transition management framework" (Kemp, Loorbach, & Rotmans , 2007). This framework is formulated for following and optimizing all themes under the sustainability transition (e.g. circularity, etc.), and can be used for re-use transition as subordinate of sustainability (Loorbach, 2010). In the next sub-section, the different organizational levels of PCOs are explained in general and in the context of the "transition management framework". The components and roles of each level in the re-use transition procedure, are explained in detail in the next sub-sections as well.

2.3.1. The organizational levels of public client organizations in the context of the re-use transition

The "Transition Management Framework" addresses 4 different levels of "strategic, tactical, operational, and reflective" for conducting sustainability transition (Loorbach, 2010). Such model can be considered as a concerete blueprint in following different sustainability pathways. Zooming into the procedure of transition towards specific sustainability target of re-use, this framework is potential to be reformulated and used as a "custemized framwrok" (Loorbach, 2010). The structure of the public client organziations, which is the key party in re-use transition in infrastructure sector, can put in the context of the custemized transition framewrok (Endo, 2022). The structure of the public client organziations contains the three levels of strategic, tactical and operational as well (Davis & Olson , 1985). To address the roles and componants of each organziational level in the re-use transition, the three levels of the public client organziations can be reformulated, using the "4 levels" within the "transition management framework" (Loorbach, 2010).

a. The organziation & transition Strategic level

The strategic level of PCOs can be addressed as the level in which the overarching, long-term targets and strategies are formulated to be followed by rest of the organization (Davis & Olson , 1985). Actors in this level, are formulating intra-organiational "policies" and conducting "evaluations" to revision the malfunctioning ones (White , 2015). From the transition management pint of view, the "strategic actors are fruntrunners" in the transition procedure, who have the unified target of providing the general administrative context for enabling the transition, which is re-use in this case (Loorbach, 2010).

b. The organization & transition tactical level

The tactical level of the public organizations has the task of using specific "tactics" to control implementation of the formulated strategies and targets to be "effective and efficient" (Davis & Olson , 1985). Within this level actors "clarify" that "*How"* the works should be done, by breaking them down and making sub-targets, detailed information, "standards" and "plannings" on the targets and strategies (White , 2015). From the "transition maangeemnt" approach, tactical actors are expected to "structure the transition" procedure and translate the re-use "strategies and goals to operational actors" by making "coalitions, detailed agendas", and manuals (Loorbach, 2010).

c. The organization & transition operational level

The operational level carries the task of putting the formulated targets by top levels into practice and conducting the projects (Davis & Olson , 1985). Based on the organzaitional defenition of this level "monitoring the procedure and result" also should be done within this level (White , 2015). From the "transition management perspective", the test protetype projects or "pilots" on the formulated targets should be conducted by actors within this level (Loorbach, 2010).

d. The transition reflective level

This level is only designated within the "transition management framework" and is not an organizational level in general (Loorbach, 2010). The task of the monitoring and evaluating of project results which is assigned to the operational level in the organizational structures, is defined under the responsibility of actors within the reflective level (Loorbach, 2010). The analysis should be on both "organziational procedures & technical aspects" and result of analysis within reflective level will be sent again to strategic level for "re-visioning of startegies" (Loorbach, 2010).

There are also specific roles which are placed on the borderlines of the defined organizational & transition levels. For instance, the role of "internal clients" can be placed between the tactical and operational level, since they are frontrunners in "translating tactical principles" into the operational level (Janse, 2021). These actors are the main in contact role with the project management team from public client side, to check periodically the quality level and "progress of projects" (Janse, 2021). The *Re-use Transition Management Framework for infrastructure projects* is reperesented in the Figure 2.4, adopted based on the Loorbach, (2010). To move towards accelerating the implementation of circular strategies within public client organizations, considering such frameworks is very useful for defining and evaluating the required activities and procedures (Franco et al., 2021).

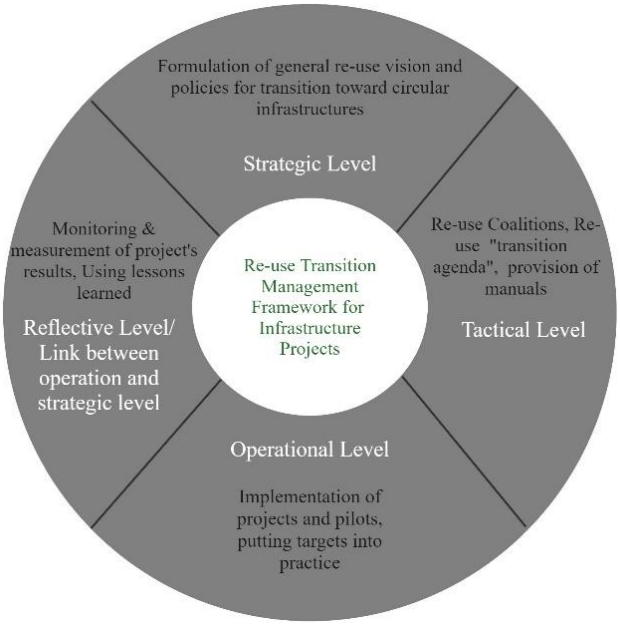

Figure 2.4. Illustration of the "Re-use Transition Management Framework for infrastructure projects", Adopted from: Loorbach, 2010, P:173).

To explore the situation with implementation of re-use strategy within the public client organization, it is required to find enablers and barriers for implementing this strategy in each organization/transition level. Currently the overarching vision on conducting circular infrastructure projects with material re-use approach are existing at the strategic level of the public client organizations. Also as mentioned, the reflective level is not existing as separate level in the organizations, and it can just be defined as a link between operational and strategic level (White , 2015). Hence, the enablers and barriers for implementing infrastructure projects with re-use strategy are required to be explored only in the tactical & operational level of PCOs. The enablers and barriers relevant to the tasks of tactical and operational level, are collected from different literatures and presented in the next section.

2.4. Enablers and barriers for implementing infrastructure projects with re-use strategy

In implementation of each circularity strategy in development of the infrastructure projects, a number of "enablers & barriers" might be existed or evolved (Ekins, et al., 2019). The enablers and barriers of implementing re-use strategy in infrastructure projects are gathered and presented in this section, using the *Research Synthesis* method (Cooper & Hedges , 2009). There are seven studies identifying enablers and barriers related to implementation of circularity strategies in different activities and sectors within the

construction industry. Since the focus of this research is re-use strategy, the enablers and barriers which were common with field of re-use have been selected. Moreover, since the scope of research is within the public client organizations, only the relevant enablers and barriers to the role of public client organizations have been selected (Rios , Grau , & Bilec, 2021). The procedure of providing the customized list of enablers and barriers for implementing re-use strategy in the public client organizations is elaborated in the AppendixA.1. Based on the defined roles and tasks in each organizational level in the previous section, each enabler and barrier linked to one of the tactical/operational or tactical & operational levels (for roles in the borderlines or relevant to both levels). Moreover, in all the studied papers, these enablers and barriers are grouped under specific categories, which are themes of that enablers and barriers. The common categories related to the tasks of public client organizations gathered as well, to structure the list of enablers and barriers. The defined categories and some of their sub-ordinated enablers and barriers are explained briefly in the next sub-section. Also, the provided list of enablers and barriers is presented in the Table 2.1.

2.4.1. Categories of enablers and barriers

The gathered enablers and barriers for implementation of re-use projects are grouped into 8 categories in this sub-section. The listed categories define the important areas that should be focused in implementing circularity strategies in projects. The categories defined with different names in each of the explored literatures. The categories are reformulated to make them more compatible with the structure of works within the public client organizations, and uniformed names are assigned to them, based on the content of each one. The enablers and barriers which are not stem from inside the organization are not addressed, since they are out of the control of organization and overcoming barriers and implementing enablers cannot be possible (Ekins, et al., 2019).

a. Knowledge, Expertise & Experiences

Improving the level of knowledge on CE strategy of re-use is very effective on the successful implementation of this strategy (Ababio & Lu, 2022). This knowledge and expertise can be gained more from market parties such as: consultants and architects (Knoth , Fufa , & Seilskjaer , 2022). The required knowledge is not only about the technical aspects and how to implement re-use projects, but also about what are the “positive (environmental) consequences” of implementing re-use strategy (Circle Economy, 2021; Nadja Yang et al., 2021; Rios , Grau , & Bilec, 2021). Some barriers like low availability or lack of actors with such knowledge and expertise within the organization can be defined under this category (Ababio & Lu, 2022; Ekins, et al., 2019; Knoth , Fufa , & Seilskjaer , 2022; Nadja Yang et al.,2021; Rios , Grau , & Bilec, 2021). Actions like holding some mandatory trainings for implementation of CE strategy of re-use (Rios , Grau , & Bilec, 2021), is one example of enablers within this category. The result of “pilots” are the most valuable knowledge bases for circular practices like re-use which should be collected and used to prevent experiencing same challenges in every projects (Knoth , Fufa , & Seilskjaer , 2022).

b. Culture, behavior and communication

Barriers and enablers under this category have also direct relation with spreading the knowledge & experiences within organization, and can hinder that or facilitate it (Ababio & Lu, 2022). Within the reviewed literatures, elements like formulation of “clear target and strategies” for re-use is relevant to “the organizational culture” and lack of them will be act in implementing the re-use strategy like a barrier (Ekins, et al., 2019; Knoth , Fufa , & Seilskjaer , 2022; Nadja Yang et al.,2021). Also, the form and the level of consistency of communications and collaborations among different organization actors and stakeholders in the procedure of implementing a circular strategy, are determining factors within the field of organizational culture and behavior (Ababio & Lu, 2022; Ekins, et al., 2019; Caldera , Ryley, & Zatyko, 2020; Nadja Yang

et al., 2021). Barriers like "resistance" of actors in implementing innovative methods like re-use, and creating changes in "as is situation" are rooted in the context of organizational culture, as well (Ababio & Lu, 2022).

c. Contracts, manuals and guidelines

This category is stems from the field of "Policies, regularities and contract developments" (Ababio & Lu, 2022) in the reviewed lists of enablers and barriers, which is more related to strategic level. However, it is changed to make a customized category for describing enablers and barriers in tactical and operational level. In this category, formulation of general regulations and policies which is a strategic task is not considered, instead formulation of detailed internal policies in tactical level as translation of the strategic visions is the target. Formulation of manuals and choosing the contract types have also regularity bases but are more tactical and operational tasks. Barriers like lack of strict and consistent guidelines for implementing re-use projects (Ababio & Lu, 2022; Caldera , Ryley, & Zatyko, 2020; Rios , Grau , & Bilec, 2021) and putting projects with re-use theme in the context of the traditional contracts (Ababio & Lu, 2022; Knoth , Fufa , & Seilskjaer , 2022), are in this field. Using forms of contracts which are more "innovative" and collaborative is one of the essential enablers for re-use projects, placed under this theme (Ababio & Lu, 2022; Knoth , Fufa , & Seilskjaer , 2022; Rios , Grau , & Bilec, 2021).

d. Organizational procedures and structures

Currently, it is argued a lot, that for implementing circularity strategies in any context, the using business model and work method should also be turned into a circular format (Ababio & Lu, 2022; Ekins, et al., 2019; Knoth , Fufa , & Seilskjaer , 2022). Apart from the work units and business model, the structure of the organization and flow of works among different sectors should also be consistent, for implementing circular strategy of re-use. The barriers and enablers relevant to work procedures and the organizational structures, have same origins and can be collected under a same category. An "innovative work procedure" and coherent structure within the organization, can make it capable for implementing new methods like re-use strategy (Ababio & Lu, 2022; Circle Economy, 2021; Knoth , Fufa , & Seilskjaer , 2022).

e. Technics and technologies for re-use/ Technical feasibility

One significant field in implementing circular strategies is use of specific technics and technologies for executing projects with these strategies and also measuring the level of success and quality of results at the end (Ababio & Lu, 2022; Nadja Yang et al., 2021; Rios , Grau , & Bilec, 2021). Barrier of lack of technical information such as: "inventory of re-usable materials and detailed execution guidelines" (Ababio & Lu, 2022; Circle Economy, 2021; Knoth , Fufa , & Seilskjaer , 2022; Rios , Grau , & Bilec, 2021) can be mentioned under this category. Lack of such technical information might cause even further barriers for project teams such as: facing complexities or making "damages" in the procedure of "detaching the materials" (Nadja Yang et al., 2021; Rios , Grau , & Bilec, 2021). Use of some specific "performance indicators" or "digital tools" which aid to implement re-use projects can act as enablers in this field (Ababio & Lu, 2022; Knoth , Fufa , & Seilskjaer , 2022; Rios , Grau , & Bilec, 2021).

f. Re-use requirements and supports

The few focused literatures on re-use, mentioned that there are extra stages for implementing re-use projects relevant to providing re-usable materials such as: transporting, adjusting and storing the reclaimed materials (Ekins, et al., 2019; Knoth , Fufa , & Seilskjaer , 2022; Rios , Grau , & Bilec, 2021). This category is unique for the re-use activities and one most important enabler under this category is provision of a consistent "storage system" for reclaimed materials by clients (Ekins, et al., 2019; Knoth , Fufa , & Seilskjaer , 2022; Rios , Grau , & Bilec, 2021). This field is more technical but also some organizational supports such as

"provision of consistent advises and supports" for operational actors are very useful in this field, to assure the success of re-use projects (Caldera , Ryley, & Zatyko, 2020).

g. Collaboration with market and supply chain

Just like regular infrastructure projects, public client organizations will collaborate with market parties for conducting projects with re-use approach. This collaboration should have a different form and some new parties should be involved to enable the implementation of these projects such as: owners of "material data bases and salvaged yards" (Circle Economy, 2021; Rios , Grau , & Bilec, 2021). Some barriers which are existing in this field are stem from the current situation in the market, such as: "lack of standards on costs of reclaimed and re-used materials" (Ekins, et al., 2019).

h. Financial aspects and economic support

The field of financial aspects is not exclusive for the re-use activities and is a normal factor to investigate the implementation of infrastructure projects. One important financial enabler which is an incentive for using re-use strategy, is the "lower cost of reclaimed materials than virgin ones" in the market (Ekins, et al., 2019). On the other hand, there is no adequate financial support for implementing the mentioned "extra stages" in re-use projects like for creating the "storage systems". (Ekins, et al., 2019; Rios , Grau , & Bilec, 2021). To find out the financial pros and cons of re-use strategy, the enablers and barriers in this field should be investigated to overcome existing barriers and prevent further ones in the next stages of projects.

The gathered enablers and barriers under each of the mentioned categories are listed in the Table 2.1. In this table, the enablers and barriers are assigned to their relevant organizational levels as well. The enablers and barriers are linked to the tactical or operational level based on the existence of relations between them, such as: cause and effect relation between the enablers/barriers and the tasks carried by the "key roles" (Ababio & Lu, 2022) in each level.

Table 2.1. Tactical and operational enablers and barriers for implementing circular infrastructure projects with re-use strategy, within public client organizations

Category	Tactical Barrier	Tactical and Operational Barrier	Operational Barrier
Knowledge, expertise &experiences	Lack of re-use knowledge (Ababio& Lu, 2022; Caldera, Ryley, & Zatyko, 2020; Ekins, et al., 2019; Knoth, Fuf , & Seilskjaer, 2022; Nadja Yang et al., 2021)	"Lack of re-use specialists" & lack of required skills/expertise in re-use field (Ababio & Lu, 2022; Circle Economy, 2021; Ekins, et al., 2019; Nadja Yang et al., 2021; Knoth , Fufa , & Seilskjaer , 2022; Rios , Grau , & Bilec, 2021)	Low number of (successful) pilots/project experiences (Ababio & Lu, 2022; Knoth , Fufa , & Seilskjaer , 2022; Rios , Grau , & Bilec, 2021)
	Lack of knowledge on positive (environmental) consequences of implementing re-use strategy (Circle Economy, 2021; Nadja Yang et al.,2021; Rios, Grau, & Bilec, 2021)		
	Lack of clear distinction among recycling & re-use activities (Circle Economy, 2021; Rios , Grau , & Bilec, 2021)		
Culture, behavior and communication	Existing priorities other than re-use: other sustainability targets, etc. (Ekins, et al., 2019)	Actor's change resistance (Ababio & Lu, 2022)	Lack of motivations for re-use & waste management (Ababio& Lu, 2022; Caldera, Ryley, & Zatyko, 2020; Knoth, Fuf , & Seilskjaer, 2022; Nadja Yang et al., 2021; Rios , Grau , & Bilec, 2021)
	Lack of clearly formulated re-use targets and strategies (Ekins, et al., 2019; Knoth , Fufa , & Seilskjaer , 2022; Nadja Yang et al.,2021)	Risk aversion attitude (Ababio & Lu, 2022; Caldera , Ryley, & Zatyko, 2020; Knoth , Fufa , & Seilskjaer , 2022; Rios , Grau , & Bilec, 2021)	
		Concerns regarding the re-sell of the reclaimed materials and material ownership (Rios , Grau , & Bilec, 2021)	
		Low integration and conduction of transition procedure from designers (Rios , Grau , & Bilec, 2021)	Negative attitudes toward re-used components and design methods (DfD[2]) :Hesitates regarding the quality, aesthetic value, and durability of reclaimed materials (Caldera , Ryley, & Zatyko, 2020; Ekins, et al., 2019; Nadja Yang et al.,2021; Rios , Grau , & Bilec, 2021)
			Complicatedness and high number of required transactions and interactions for re-use (Ababio & Lu, 2022; Nadja Yang et al.,2021)
			Lack of "compatible collaborative" procedures/ approach, and methods (Ababio& Lu, 2022; Caldera, Ryley, & Zatyko, 2020; Ekins, et al., 2019; Nadja Yang et al., 2021)
			Lack of consistent communications and transparency among actors/actors and stakeholders (Ababio & Lu, 2022; Caldera , Ryley, & Zatyko, 2020; Nadja Yang et al., 2021)
Contracts, manuals & guidelines	Using contract types and procurement procedures with low flexibilities (Ababio & Lu, 2022; Knoth , Fufa , & Seilskjaer , 2022)		Lack of roles with responsibilities on drafting, documenting and certify re-use works (Ababio & Lu, 2022; Knoth , Fufa , & Seilskjaer , 2022)
	Lack of strict, consistent and explicit re-use guidelines (Ababio& Lu, 2022; Caldera, Ryley, & Zatyko, 2020; Ekins, et al., 2019; Knoth, Fuf , & Seilskjaer, 2022; Rios , Grau , & Bilec, 2021)		

[2] DfD: Design for Detachability

	Lack of specific internal imposing and supporting procedures for re-use (Ababio & Lu, 2022; Knoth , Fufa , & Seilskjaer , 2022)		
	Current internal strict policies, regulations and complex, iterative administrative works for projects (Ababio & Lu, 2022; Caldera , Ryley, & Zatyko, 2020; Knoth , Fufa , & Seilskjaer , 2022; Rios , Grau , & Bilec, 2021)		
	Guarantee and warrantee problems with reclaimed materials (Ababio & Lu, 2022; Rios , Grau , & Bilec, 2021)		
Organization procedures and structures	Use of linear and incoherent business models, for long duration (Ababio& Lu, 2022; Ekins, et al., 2019; Knoth, Fuf , & Seilskjaer, 2022; Rios , Grau , & Bilec, 2021)	Inadequate in-house resources and capacity for renovation of business model (Ababio & Lu, 2022; Ekins, et al., 2019; Knoth , Fufa , & Seilskjaer , 2022)	
Technics and technologies for re-use/Technical feasibility	Lack of required technical documents for re-use; material inventories, technical guidelines (Ababio & Lu, 2022; Circle Economy, 2021; Knoth , Fufa , & Seilskjaer , 2022; Rios , Grau , & Bilec, 2021)	Lack of re-use R&D projects on Developing required new technologies for: Conducting reclamation audits, evaluating component's strength and quality, categorizing reusable components, etc. (Ababio & Lu, 2022; Nadja Yanget al., 2021; Rios , Grau , & Bilec, 2021)	Incompatibility between functions and targets of old project (project of reclaimed materials) and new projects (Circle Economy, 2021; Rios , Grau , & Bilec, 2021)
	Low amount of available data on used and reclaimed materials (quantity and quality, availability, etc.) (Ababio & Lu, 2022; Circle Economy, 2021; Rios , Grau , & Bilec, 2021)	"Mismatch between the current DFD tools and BIM" models: Issues with visualizing DFD and other design principles & lack of re-use indicators within the digital tools (EOL, LCA, etc.) (Ababio & Lu, 2022; Circle Economy, 2021; Rios , Grau , & Bilec, 2021)	Possible material damages under deconstruction operations/ Complex design of projects and impossibility of disassembly (Nadja Yang et al.,2021; Rios , Grau , & Bilec, 2021)
			Existing material life spans and need for materials with high EOL (long life span) (Ababio & Lu, 2022; Rios , Grau , & Bilec, 2021)
			Technical Challenges in adjustment of detached materials (Ababio& Lu, 2022; Knoth, Fuf , & Seilskjaer, 2022; Nadja Yang et al., 2021; Rios , Grau , & Bilec, 2021)
Collaboration with Market & supply chain	Lack of standards on costs of reclaimed and re-used materials (Ekins, et al., 2019)		Low supply & demand for re-use in the market, and fragmentation between them: Low number of demolition projects with re-usable elements, and low demand for circular projects (Ababio& Lu, 2022; Caldera, Ryley, & Zatyko, 2020; Circle Economy, 2021; Ekins, et al., 2019; Knoth, Fuf , & Seilskjaer, 2022; Nadja Yang et al., 2021)
Re-use Requirements and support	Lack of consistent storage system for reclaimed materials (transportation, storage, adjustment and material test facilities) (Ekins, et al., 2019; Knoth, Fuf , & Seilskjaer, 2022; Rios , Grau , & Bilec, 2021)		Lack of early stage cost and time planning for re-use (Knoth , Fufa , & Seilskjaer , 2022)

Financial aspects and economic supports	Restricted budget and funds (Ababio & Lu, 2022; Nadja Yang et al., 2021; Rios, Grau, & Bilec, 2021) High level of financial risk of re-use for client and contractor (Knoth , Fufa , & Seilskjaer , 2022) Low financial motivations for implementing extra efforts on re-use for internal and external actors (Ekins, et al., 2019; Rios , Grau , & Bilec, 2021)		Higher transactional costs of re-use than cost of raw materials; cost of interactions, cost of marketing, market costs for extra project stages in pilots and projects, etc. (Ababio& Lu, 2022; Caldera, Ryley, & Zatyko, 2020; Knoth, Fuf , & Seilskjaer, 2022; Rios , Grau , & Bilec, 2021)
Category	**Tactical Enabler**	**Tactical and Operational Enabler**	**Operational Enabler**
Knowledge, expertise and experiences	Holding Mandatory trainings for CE strategies implementation (Rios , Grau , & Bilec, 2021)	Existing general "Knowledge on circularity" & "Keen to learn more about that from actors" (Circle Economy, 2021; Ekins, et al., 2019; Knoth, Fufa, & Seilskjaer, 2022)	Experts trainings for re-use (functions of deconstruction & demolition to release intact materials for re-use, circular project management, design for circularity, maintenance with re-use approach, etc.) (Rios , Grau , & Bilec, 2021).
	Clarifying Environmental effects of recycling and re-use (Caldera , Ryley, & Zatyko, 2020; Rios , Grau , & Bilec, 2021)	Sharing re-use knowledge with stakeholders (contractors, suppliers, etc.) (Ababio & Lu, 2022; Circle Economy, 2021; Rios , Grau , & Bilec, 2021)	Pilot projects/ positive previous re-use project experiences (Knoth , Fufa , & Seilskjaer , 2022)
	Formulating detailed re-use guidelines for each department/role: transport guideline, design guideline, etc. (Rios, Grau, & Bilec, 2021)		Consulting with CE consultants and re-use experts in different stages: design procedure, etc. (Ekins, et al., 2019; Knoth , Fufa , & Seilskjaer , 2022; Rios , Grau , & Bilec, 2021)
	Providing data bases for reclaimable materials in the area (Circle Economy, 2021)		
Culture behavior and communication	Preparing the context & motivating for cultural/behavioral change &adoptability (Ababio & Lu, 2022; Knoth , Fufa , & Seilskjaer , 2022; Nadja Yang et al., 2021; Rios , Grau , & Bilec, 2021)	Positive attitudes towards result of circular projects and being Open to change (Ekins, et al., 2019; Nadja Yang et al., 2021)	"High quality" and consistent Collaborations among involved actors (Caldera , Ryley, & Zatyko, 2020; Circle Economy, 2021; Knoth , Fufa , & Seilskjaer , 2022; Nadja Yang et al., 2021)
	Developing leadership style for re-use (Ekins, et al., 2019; Nadja Yang et al.,2021; Rios , Grau , & Bilec, 2021)	Developing circular and specifically re-use mindset within organization by creating "sense of urgency" and clarifying financial advantages and values of circular and specifically re-use projects for the actors (Nadja Yang et al., 2021)	Formulating and implementing significant participation and communication plan between stakeholders (Caldera , Ryley, & Zatyko, 2020; Circle Economy, 2021; Knoth , Fufa , & Seilskjaer , 2022; Nadja Yang et al., 2021)
Contracts, manuals & guidelines	Defining ambitious targets &plans for re-use of salvaged materials/reclaimed materials (Knoth , Fufa , & Seilskjaer , 2022; Nadja Yang at al., 2021; Rios , Grau , & Bilec, 2021)	Formulating and implementing standards for environmental impact and quality evaluation of re-use procedure/more integration of re-use in sustainability appraisals (Ababio & Lu, 2022; Caldera , Ryley, & Zatyko, 2020; Rios , Grau , & Bilec, 2021)	Implementing innovative procurement models, public/private partnerships & Integrated project delivery methods (Ababio & Lu, 2022; Knoth , Fufa , & Seilskjaer , 2022; Rios , Grau , & Bilec, 2021)
	Formulating warranties for the safety and quality of reclaimed materials (Rios , Grau , & Bilec, 2021)		Emphasizing more on re-use in Planning stage of project (Circle Economy, 2021)
	Creating roles with responsibilities on drafting, documenting and certify re-use works/steering the transition (Ababio & Lu, 2022; Knoth , Fufa , & Seilskjaer , 2022; Rios , Grau , & Bilec, 2021)		
	Formulating specific design guidelines and principle for re-use: DFD, etc. (Ababio & Lu, 2022; Caldera , Ryley, & Zatyko, 2020; Circle Economy, 2021; Rios , Grau , & Bilec, 2021)		
	Impose re-use responsible forces on operational actors (Knoth, Fufa, & Seilskjaer, 2022)		

	Formulating Sustainable procurement guidelines with specific re-use considerations, selection and award criteria (Rios, Grau, & Bilec, 2021)		
Organizational procedures & structures	Creating capacities for innovation development within the organization (Knoth , Fufa , & Seilskjaer , 2022)		
	Formulating innovative work procedures compatible with re-use targets, circular frameworks and business models (Ababio & Lu, 2022; Circle Economy, 2021; Knoth , Fufa , & Seilskjaer , 2022)		
Technics and Technologies for re-use/Technical feasibility	Development of new tools for collaborations and information flows (Ababio & Lu, 2022; Rios , Grau , & Bilec, 2021)	Digitalizing CDW[3] management (storage and process of materials for re-use): use of machine learning, etc. (Circle Economy, 2021; Rios, Grau, & Bilec, 2021)	Try to match the supply and demand side of reclaimed material's within the market (Circle Economy, 2021; Rios , Grau , & Bilec, 2021)
	Collaborating "with existing salvaged yards" and innovative companies created for reclaimed materials (Rios , Grau , & Bilec, 2021)	Providing more re-use ICT supports; BIM, DFD,… (Ababio & Lu, 2022; Knoth, Fufa, & Seilskjaer , 2022; Rios , Grau , & Bilec, 2021)	Providing Regular system for transport and storage of reclaimed materials (Rios , Grau , & Bilec, 2021)
		Development of innovation in re-use field in R&D Units: technologies to track material's lifecycle, quality and safety assessment of reclaimed materials, decontaminating the reclaimed materials, disassembly technologies (Rios, Grau& Bilec, 2021)	
Collaboration with market & supply chain		Use and cooperate with current inventories, data bases and salvaged yards in the market (Circle Economy, 2021; Rios , Grau , & Bilec, 2021)	
Requirements and support	Providing consistent advises and supportive services to operational actors in re-use projects (Caldera , Ryley, & Zatyko, 2020)		
Financial aspects and economic supports	Crating financial stimulus for internal and external collaborators with re-use targets like CE R&Ds, current storage facilities, digital inventories, etc. Like: shared risks, funds etc. (Ababio & Lu, 2022; Caldera , Ryley, & Zatyko, 2020; Knoth , Fufa , & Seilskjaer , 2022; Rios , Grau , & Bilec, 2021)		
	Existing lower costs of purchasing reclaimed materials than virgin materials (Ekins, et al., 2019)		

[3] CDW: Construction Demolition & Waste

To be able to accelerate this transition, it is important to implement the forecasted enablers and take advantage from existing enablers to overcome the barriers. Not all the gathered enablers are clear and detailed enough to overcome the barriers in implementation of the re-use strategy, and some other factors are required. Currently, for implementing circularity in other sectors, many frameworks are provided and put into practice. To the knowledge of author, there is not yet any specific framework which can facilitate the implementation of re-use strategy in the infrastructure projects to be used by public clients. In the next section, 9 circularity frameworks have been found and through conducting a "*Research synthesis*" method (Cooper & Hedges , 2009), common circularity implementation factors compatible for implementing re-use strategy extracted from them.

2.5. Circularity implementation factors fit for re-use strategy

Implementation of innovative approaches and "systematic" changes accompanied by circularity strategies, require development of a "well-structured framework" (Ababio & Lu, 2022), to use as blueprint. In moving towards realization of a "CE target", implementation of a specific framework can make the transition process less complicated (Circle Economy, 2021). Various circularity frameworks have been developed until now in different sectors within the construction industry (e.g. built environment), and other industries. Within the infrastructure sector, there is also an urgent need for development of a framework to accelerate implementation of re-use strategy at operational level of the public client organizations. In this section, 9 circularity frameworks are reviewed and repeated circularity implementation factors between them which were fit for re-use practices are extracted through conducting a *Research Synthesis* method (Cooper & Hedges , 2009). The 9 reviewed frameworks selected through searching different keywords relevant to the topic such as: frameworks for implementation of material re-use strategy, circularity frameworks, frameworks for filling the gap between operational and tactical level of transitions, organizational framework for implementation of CE strategies, circularity framework in construction sector, etc. The reviewed circularity frameworks are explained briefly in the Appendix A.2. All 9 frameworks are summarized in the Table 2.2, including; framework's name, the sector in which the framework is formulated, the transition level which is addressed by the framework, the focus point and the concentrated circularity strategy.

Table 2.2. Summary of the 9 reviewed circularity frameworks

No.	Framework's Name	Sector	Recognized transition levels	Focus point	Concentrated circularity strategy
1	BECE	General production	Tactical & Operational	Filling the gap between the tactical and operational level	10Rs
2	Bloom (BLOI)	Construction	Operational	Provision of a matrix as a tool for developing circular constructions	10R
3	Circular Construction Framework	Construction	Tactical &Operational	Provision of a detailed and stepwise framework for initiation and management of circular construction projects	10Rs
4	RISE	Construction & Demolition	Reflective	Identification of indicators for measuring the circularity level in construction and demolition projects	10Rs
5	Re-Use Collaboration Model	Built Environment	Operational	Provision of a communication and collaboration plan for involved actors in each phase of projects with re-use strategy	R2: Re-use
6	FCRBE Re-use Guideline	Built Environment	Tactical & Operational	Provision of a detailed guideline for public clients to commission and conduct projects with re-use strategy	R2: Re-use
7	Bridge circularity assessment framework	Infrastructure (Bridge development)	Reflective	Identification of indicators for measuring the circularity level of bridges in construction and asset management phase	10Rs
8	The 8 Test Framework	General production	3 Levels	Provision of fundamental questions to investigate the "capability" of current organizational models to implement circularity strategies & targets	10Rs
9	The strategies for implementing Circularity in POs	General production	3 Levels	Provision of organizational strategies for implementing CE targets in the public client organizations	10Rs

The circularity implementation factors which are repeated within at least 2 of reviewed frameworks, and fit for implementing the infrastructure projects with re-use strategy, collected as potential organizational factors for implementing re-use strategy in this sector. Moreover, some detailed factors which could be categorized under the gathered implementation factors, collected as sub-factors for implementing re-use projects. The sub-factors are customized factors for implementation of circularity strategy of re-use. The potential organizational factors & sub-factors for implementing circular projects with re-use strategy extracted from 9 existing circularity frameworks, are presented in the Table 2.3. These factors & sub-factors can be used in the final framework for tackling the barriers and implementing the enablers mentioned in the previous section, to accelerate the implementation of re-use strategy at operational level of public organizations.

Table 2.3. Potential organizational factors & sub-factors fit for implementing circular projects with re-use strategy extracted from 9 existing circularity frameworks

No.	Organizational circularity implementation factors	Sub-factors	References
1	Defining specific circularity strategy & targets	Including the re-use strategy & targets within manuals and internal policies in the organization	(Klein, Deutz, & Ramos, 2021; Philipp et al., 2022; Tobben & Opdennaker , 2022)
		Defining clear re-use ambitions from initiation phase of projects	(Geerts, Ghyoot, & Naval, 2020; Mendoza et al., 2017; Tobben & Opdennaker , 2022)
2	Structuring collaborations with external parties in implementation of circularity strategy	Making use of integrated form of contracts compulsory for re-use projects	(Mendoza et al., 2017; RVB, 2022; Tobben & Opdennaker , 2022; Trabulsi & Sofipour, 2020)
3	Structuring internal & external communications for implementation of circularity strategy	Providing detailed communication models for involved actors in each stage of project lifecycle to prevent possible conflicts	(Mendoza et al., 2017; RVB, 2022; Tobben & Opdennaker , 2022; Trabulsi & Sofipour, 2020)
4	Formulating guidelines and specific work units For implementation of circularity strategy	Make customized and detailed re-use guidelines for involved actors to follow up based on project's specifications and stages: re-construction/ construction from scratch project/material detaching phase & material implementing phase	(Geerts, Ghyoot, & Naval, 2020; RVB, 2022; Tobben & Opdennaker , 2022)
5	Knowledge development on circularity strategy	Focusing more on re-use knowledge development; formulation of shared knowledge sessions, trainings/workshops, and components re-use information labels	(Klein, Deutz, & Ramos, 2021; Mendoza et al., 2017; Tobben & Opdennaker , 2022)
6	Adopting Project management activities for certain circular strategy	Adopting project management tasks based on circular strategy of re-use	(Geerts, Ghyoot, & Naval ,2020; Superti , Houmani , & Binder , 2021; Tobben & Opdennaker, 2022)
7	Investigating potentials for implementing the circularity strategy	Identification of re-use potentials in current projects regularly to take advantages for the future projects	(Geerts, Ghyoot, & Naval ,2020; RVB, 2022; Tobben & Opdennaker , 2022)
		Testing the current assets and suggested designs or formulate reward criteria based on general or organizational re-usability indicators: re-usability, transportability, uniqueness, disambality, etc.	(Coenen, 2019; Coenen et al., 2021; RVB, 2022)
8	Technical/organizational Follow ups on implementation of circularity targets &strategies and evaluating them	Regular follow-ups and revising stages for re-use projects	(Klein, Deutz, & Ramos, 2021; Mendoza et al.,2017)
		Gathering periodic reports and feedbacks on reuse practices to reformulating the visions/ambitions	(Klein, Deutz, & Ramos, 2021; Mendoza et al., 2017)
		Evaluating the organizational models and re-use activities in different levels of organization regularly, with developed indicators; quality and quantity of research activities, project execution in operational level and reuse support, re-use enabling activities and internal policies at tactical level/ testing all structures, processes, people performance and internal strategies in terms of re-use implementation	(Klein, Deutz, & Ramos, 2021; Mendoza et al., 2017; Philipp et al., 2022; Superti , Houmani , & Binder , 2021)
		Defining re-use organizational and technical analyzers	(Klein, Deutz, & Ramos, 2021; Philipp et al., 2022)
9	Organization extension and adaptation, for implementing circularity strategy	Defining specific re-use sector for steering re-use activities, reporting and archiving results for evaluation	(Klein, Deutz, & Ramos, 2021; Philipp et al., 2022)
		Involving re-use specialists/ambassadors	(Klein, Deutz, & Ramos, 2021; Philipp et al., 2022; Superti , Houmani , & Binder, 2021; Trabulsi & Sofipour, 2020)

2.6. Chapter conclusion & Next stages

In this chapter different literatures and theoretical frameworks in the fields of circularity and re-use of material in the construction industry and infrastructure sector have been investigated. The main target of this review was answering the SRQ1 and SRQ2 including: identification of the enablers and barriers for

implementation of circular infrastructure projects with material re-use strategy within public client organizations, and potential organizational factors for implementing these projects.

Re-use is quite an innovative approach in the construction and specifically infrastructure sector. Hence, in this chapter, first the topic of circularity and specific strategy of re-use of material in construction industry and infrastructure sector have been investigated. Implementation of this strategy requires a systematic change in conducting infrastructure projects, which can be recognized as a transition. The re-use transition in the infrastructure sector, is currently locked at tactical level of public organizations, and behind the acceleration phase. To make the implementation of re-use projects accelerated at operational level of public organization, each levels of tactical and operational should be zoomed in and investigated. In this regard, public client organizations considered in the context of the 'Transition Management Framework', and the roles and activities of actors within each level explored in both organization and transition contexts. Elaboration of each of the two levels helped to find the origin of enabler and barriers for implementing re-use projects, as well. To gather the enablers and barriers, 7 different lists of enablers and barriers for implementing circularity strategies in construction industry have been investigated. The relevant enablers and barriers to re-use activities in the infrastructure sector have been collected under 8 common categories in investigating implementation of circularity strategies (Table 2.1). These categories are *Knowledge, expertise & experiences/ Technics, technologies for re-use and technical feasibility/ Re-use requirements and support/ Contract, manuals and guidelines/ Organizational procedures & structures/ Culture, behavior & communication/ Collaboration with market & supply chain, and Financial aspects and economic supports*. Each enabler and barrier linked to its relevant organizational/ transition level and category, to make the further investigations in next chapters easier. Other than tactical and operational level, an intermediary level has been identified as 'Tactical & Operational', which defines enablers and barriers stem from or related to both tactical and operational levels, or exists at borderline of the two levels.

To find the compatible organizational factors fit for implementing the re-use strategy, various existing circularity and re-use frameworks have been reviewed, and common factors have been collected from them (see Table 2.3). Detailed factors for implementing re-use projects mentioned within the reviewed frameworks, have been also gathered. These detailed factors recognized as *sub-factors* for implementation of re-use strategy.

The collected list of enablers and barriers, and list of implementation factors & sub-factors, will be used as theoretical bases in conducting further stages of research.

In the next chapters, through following an empirical study phase, the gaps in practice in implementing re-use strategy within the public client organizations will be identified. The first phase of empirical study will be conducting a document review within the case public client organization of Municipality of Den Haag. The gaps will be identified through exploring the level of connections between the two levels of tactical and operational in implementing the circularity strategy of re-use. In the second step, through semi-structured interviews, the enablers and barriers gathered from literatures will be checked by practitioners in each level, to be shortlisted. The gathered implementation factors & sub-factors will be used in the final stage of research as potential factors to deal with the identified gaps, which will provide a part of the final framework.

Chapter 3:

Document Review

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CHAPTER3: DOCUMENT REVIEW

This chapter, focused on reviewing the documents of the case organization of Municipality of Den Haag, to define the links, and distinctions/gaps in practice among the tactical and operational level of the public client organizations in implementing the re-use strategy. The aim of the document review phase is providing the answer of the SRQ3, which is as follows;

SRQ3: How does the current procedures and guidelines at the tactical level for implementing circular strategy of re-use relate to the practices at the operational level?

To provide answer for this sub-question, various documents used by the municipality organization, have been gathered and reviewed including: external agreements, strategy and policy documents from governments and other public organizations, internal policies, guidelines, frameworks, pilot and project reports. The reviewed documents are collected from both tactical and operational level of the Municipality of Den Haag, to find adequate information from current situation of conducting and implementing infrastructure projects with re-use strategy. The documents are reached through internal and external data storages in the Municipality of Den Haag and categorized in the Table 3.1, based on the document's type, availability, theme (sustainability/circularity/re-use), Document's (anonymized) name, and their relevant organizational/transition level. A code has also been assigned to each internal document, which contains the letters DH, as abbreviation of 'Den Haag', and a number. Referring to these anonymized documents is through the assigned codes all over the chapter.

The reviewed documents are gathered based on three main themes of:

1. General work procedures (without specific focus on circularity) for projects.
2. Documents regarding sustainability considerations within projects with theme of 'sustainable material use' specifically.
3. Documents regarding implementation of circular projects and projects with 'material re-use' theme specifically.

The logic behind identification of these three themes is the existing relevance between them within the organization. Currently among the organization's documents, the re-use strategy is still underneath of 'material use' theme in sustainability considerations. Moreover, the 're-use' theme is just recognized separately within few conducted circularity pilot projects. The reason of focusing on regular organizational workflow is that; all sustainability and circularity projects are still conducted actively through the regular work procedure (as in other type of projects). The gathered information from documents is representing in three separate sections in this chapter. In section 3.1. the general work procedure for implementing projects within the municipality is briefly explained. Section 3.2. indicates the current procedures and guidelines in tactical level of the organization regarding the re-use or sustainability material theme. Section 3.3. is representing the current situation regarding implementation of the re-use projects and projects with sustainable material use theme at operational level of this organization. At the end of this chapter, a comparison is conducted between the current situation regarding implementation of re-use strategy, in the two organizational/ transition levels in the section 3.4. Lastly, the chapter conclusion is formulated in the section 3.5, in which the distinctions and relations between the two levels of tactical & operational are explained.

Table 3.1. Overview of the reviewed documents

No.	Type of Documents	Availability	Document's Theme	Document's Name/Anonymized Name	Organizational /transition level
1	Strategies, policies and agreements	External; government websites	Circularity	1.National Raw Material Agreement (Government of the Netherlands, 2016) 2.Clean Air Accord (Central Government, 2020) 3.Green deals agreements (European Commission, 2023)	Strategic
2	Organizational chart and general work procedures	Internal & External	Regular Projects	1.Municipality's organizational structure 2.General work procedure (DH1) 3.Explanation on different project phases (DH2)	Strategic/tactical
3	Policy documents, Manuals &guidelines	Internal	Sustainability	1.Sustainability commissioning physical domain (DH3) 2.Action plan for socially responsible procurement (SRP) (DH4) 3.Sustainability scan (DH5) 4.Sustainability knowledge team report (DH6) 5.Formulating sustainability ambitions (DH7) 6.Project ambition web (DH8)	Tactical
4	Research and pilot projects owned by other public organizations	External; Rijkswaterstaat[4] website	Circularity; Re-use theme	1.Rijkswaterstaat re-use strategy advice (Rijkswaterstaat, 2023) 2.Closing the Loop consortium (Rijkswaterstaat, 2021) 3.Advisory document on Procurement of circular projects (DH9)	Strategic/tactical/ operational
5	Project's outcomes and project reports	Internal	Sustainability; Material theme	1.Sustainability scan report of projects (DH10) 2.Project's preparation documents (DH11) 3.project reports (DH12) 4. Project ambition web (DH13) 5. Project's communication and participation plan report (DH14)	Operational
6	Shared project's and pilot project' outcome reports and advisory reports	Internal & external with restricted access to Municipality	Circularity/re-use theme	1.Quay wall renovation pilot project (DH15) 2.Building material inventory (DH16) 3.External advisory document on pilot project (FH17) 4. Internal advisory document on pilot project (DH18)	Operational

3.1. Organizational structure and work procedures within the Municipality of Den Haag

To gather a better clue on how the Municipality of Den Haag is organized and how different types of projects like circular ones are conducted within that, first, organizational structures and work procedures within this public organization is discussed. In this section, the Municipality of Den Haag & its involved departments in

[4] Rijkswaterstaat: Netherland's Ministry of Infrastructure and Water Management, https://www.rijkswaterstaat.nl/

infrastructure projects, and the general work procedures in these projects are represented in sub-sections 3.1.1 and 3.1.2 respectively.

3.1. 1. Municipality of Den Haag and its departments

Within the Netherlands, the city of Den Haag is one of the three largest cities with population of higher than "560000" residents (The Hague in numbers , 2023). The city with other 20 municipalities constitute the "metropolitan area", which itself is a sub-ordinate of another urbanism section; the "Randstad" (The Hague in numbers , 2023). The Den Haag itself is divided into "8 districts and 44 neighborhoods in general", in which "the Den Haag Central" Is the most extensive one, governed by "the Municipality of Den Haag" (The Hague in numbers , 2023).

Within the Municipality of Den Haag, different departments have relevant role to the construction and development works, embedded in a hierarchy and organizational structure. Some of the relevant departments have active roles within projects or their preparation phases. However, there are some other departments who have more advisory, and supportive roles in different fields, and can be recognized as passive ones within the construction and development projects. The organizational structure of the municipality showing the relationship between these different departments, which is indicated in the Figure 3.1, based on the municipality organizational chart (The Municipal Organziation , 2023). The Local council, the board of Mayor and alderman and Town Clerk are in charge of administrative works, and include the strategic level of the Municipality (The Municipal Organziation , 2023). Below that, each of the "municipal executive departments", carries distinctive type of affairs (The Municipal Organziation , 2023). In terms of involving in the construction of infrastructures and city development projects, there are two main departments of the Urban Development (DSO) and the City Management (DSB), in close contact with each other.

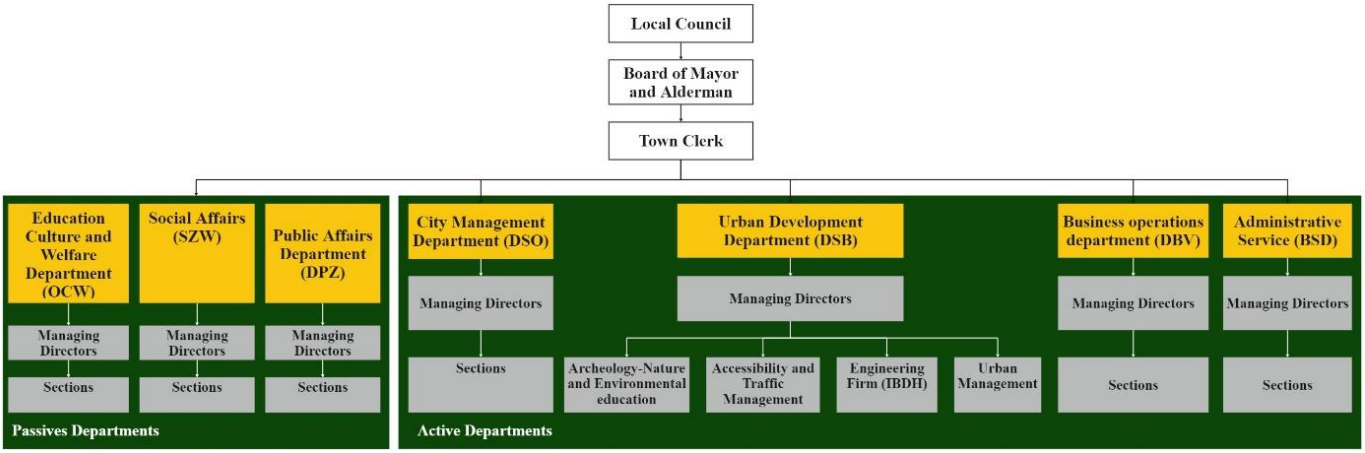

Figure 3.1. Organizational structure and hierarchy between different active and passive departments, involved in the construction and development works of the Municipality (Adopted from The Municipal Organization, 2023)

Other active departments are the Municipal Administration (BSD) and the Operations Management (DBV), with more controlling and supportive roles. Also, there are some sections of other departments with advisory roles in specific type of projects (like sustainable ones, etc.) including: 'Well-being' within the Education, Culture and Welfare (OCW), 'City Districts and Neighborhood' within the Public Services (DPZ), and the Social Affairs (SZW) (The Municipal Organziation , 2023). Each department has a tactical level, which is the managing or general directory section on the top of department. Below these directory levels, different sections are active, such as Accessibility and Traffic Management, Urban Management, and Engineering Firm (IBDH). Among these departments, the operational tasks are mostly carrying out by the Engineering firm (IBDH), and some parts of DSO department. The DSO has also tactical sections, which issue approvals and permits for projects. In

general, the tactical and operational level of Municipality in conducting infrastructure projects is distributed between different departments. The work procedure within the IBDH department for preparing and developing an infrastructure project in general is elaborated in the next sub-section.

3.1.2. General work procedure at operational level

Based on the internal document DH1, to initiate and implement projects within the Municipality of Den Haag, specific steps should be followed, as the general work procedure for all projects. This procedure, is same in any public client organization in construction industry and contains various phases. The first phase is the initiation of project, including preparation works. Most of the first step is carried out by the IBDH department in consultation with other sections like DSO& DPZ. Based on the decision made in consultation with the procurement department (DBV) the project will be carried out with a specific contract model which is mostly traditional. Formulating project specifications, like sustainability targets will be occurred before the tender phase. The complete work procedure which is followed within the municipality in conducting infrastructure projects (including sustainable projects) illustrated in the Appendix B.1, based on the internal document DH2. To find out specific information regarding considerations in projects with re-use theme within this organization it is important to explore the tactical and operational level of the organization separately, and make comparison. The focus is on integrated policies, implementation procedures and project ambitions regarding re-use strategy in this organization. In the next section, the gathered information from different documents on current situation, integrated internal and external policies and guidelines in tactical level regarding re-use projects is explained.

3.2. Tactical level of the municipality in conducting re-use projects

In this section, the integration of re-use approach at tactical level is reviewed. The tactical documents of the municipality organization, recognize the re-use approach as sub-ordinate of circularity and sustainability targets with ‘material theme’. Hence to explore all existing active sections, policies and guidelines within this organization regarding material re-use, all documents on circularity and sustainability have been reviewed.

3.2.1. Sustainability at tactical level of the Municipality of Den Haag

The Municipality of Den Haag is one of the frontrunners around the globe, in working in line with the “17 United Nations sustainability development goals”, and adopting the work procedures with these targets (Sustainable Development Goals, 2023). For each sustainability ambition, the municipality is committed to a separate agreement inputted from the Dutch government; such as agreements within the “Green Deals” program (EUROPEAN Commission, 2023), and the “Raw Material Agreements” (Government of the Netherlands , 2016). In this regard the current tasks at the tactical level of the Municipality have sustainability priorities which are formulated in 4 different themes including: energy transition (rotation from fossil fuels to renewable sources), livability of the outdoor environment (e.g. developing more greeneries), “accessibility”, and sustainable provision of materials (The Hague , 2018). Within the tactical level, DSO is the frontrunner in the first two sustainability themes and has the crucial task of safeguarding a strong connection with each sub-ordinate responsible teams. Most important tasks of DSO in this regard are: providing and sharing the required knowledge, conducting easy way of communications, formulating external collaborations, networking and participating in various pilot projects (The Hague , 2018). In some themes, advisors from the DPZ and OCW are also collaborating with the DSO department. In the theme of sustainable provision of materials, the steering role of DSO and other tactical departments is mainly in the field of management of resources with shared methods in fields like mobility, and not re-use in construction projects. In recent years, a coalition has been made between some actors from different departments of the Municipality, working on sustainability topic. The coalition is called the ‘*Sustainability Knowledge Team’*. Structure of this coalition and their activities are explained in the next sub-sections.

a. The Sustainability Knowledge team within the Municipality

According to the internal document DH6, the 'sustainability knowledge team' is developed to reach the formulated sustainability targets under the 4 mentioned sustainability themes in the Municipality of Den Haag. The team is including actors from different departments. Among the departments, the DSO &DSB have more proactive and conducting roles. The DSO has also its own internal sustainability team, and use different knowledge and expertise from other teams occasionally. The involved departments in the "*sustainability knowledge team"* of the Municipality is depicted in the Figure 3.2. One important program which has been ran by this knowledge team is the *Sustainable Commissioning Program*, which is explained in the next sub-section.

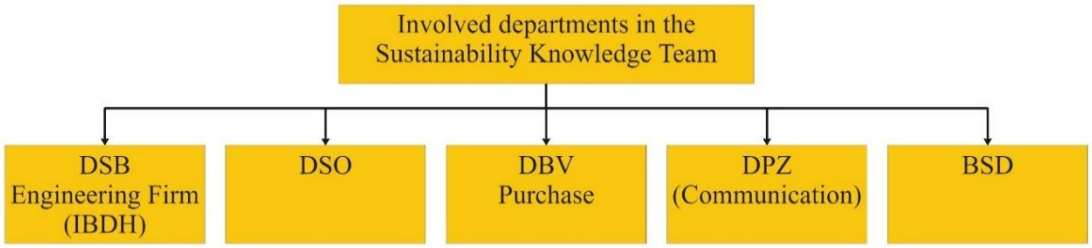

Figure 3.2. Illustration of involved departments in the "sustainability knowledge team" (Adopted from internal document: DH6).

b. The Sustainable Commissioning Program

According to the internal documents DH3 & DH6, one of the important tasks of the sustainability knowledge team is running the 'sustainable commissioning program', which is aimed to reach the sustainable ambitions of the Municipality. Two main targets in this program are; reduction of the CO2 emission and reducing the amount of raw material consumption in realization, management and maintenance of projects. The 'sustainability knowledge team', is trying to provide the context by increasing the quality of communications on sustainability ambitions within the Municipality, introducing required tools, and implementing, monitoring & reflecting on a "sustainable commissioning method". The sustainable commissioning is focused only on operational level and different project phases, and not integrate the link between operational activities and tactical procedures. The detailed illustration of method is provided in the Appendix B.2. The procedures are formulated to be integrated in each project based on project's specific sustainable targets and requirements. The use of procedures and tools in this model, which are useful for circularity and re-use targets (ambition web, etc.) are investigated at operational level and presented in the next section. According to the internal documents DH3 & DH4, the sustainable commissioning program is based on the "Action plan for socially responsible procurement (RIS)" which provided by the Municipality of Den Haag in 2020. This Action plan also formulated criteria for purchasing and commissioning projects with sustainable and socially responsible ambitions. Under this plan, the Socially Responsible Procurement (MVI) is provided, including themes like, innovative procurement.

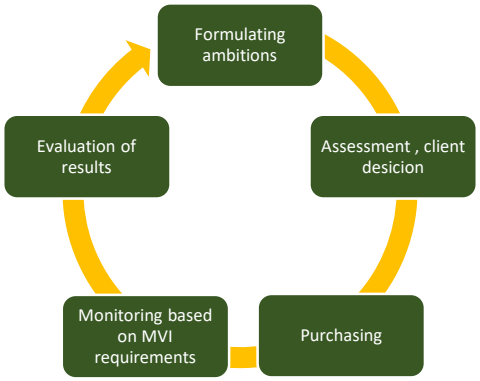

Figure 3.3. Illustration of phases of the socially responsible procurement framework (MVI) (Adopted from an internal document: DH4)

Implementation of this action plan requires following a 5 step procurement framework (see Figure 3.3). Re-use projects as sustainable and innovative projects can also be done using this framework, however, the framework is like a traditional model with extra stage of sustainable ambition formulation.

3.2.2 Circularity at tactical level of Municipality of Den Haag

Circularity is one of the main targets defined within the sustainable commissioning program by the Municipality of Den Haag. In this specific theme, the Municipality is committed to the "Netherlands National Raw Material Agreement", commissioned by the Rijkswaterstaat at 2017 (Government of the Netherlands , 2016). Based on this agreement, the transition towards a fully circular economy in the Netherlands by 2050 is tried to be accelerated (Government of the Netherlands , 2016). The main ambition in this agreement is consumption of "50% lower raw materials by 2030" (Government of the Netherlands , 2016). Defining the transition teams and monitoring procedures, formulating indicators, checking material flows and dynamics within transition process periodically are the substantial actions defined in this agreement to accelerate the transition (Government of the Netherlands , 2016). Currently some public-private coalitions have been developed in the Netherlands context for following the circularity targets defined within the "climate agreement" (Central Government, 2020), and the "National Raw Materials agreement" (Government of the Netherlands , 2016). The "closing the Loop" is one coalition including 10 different public and private organizations; such as municipalities, innovative construction and knowledge provider companies (Rijkswaterstaat, 2021). This coalition is focused on maximizing the quality of re-use works and reaching the target of full re-use in infrastructure sector (Rijkswaterstaat, 2021). To reach this target, this consortium is following-up different innovations such as: "Conducting the re-usability scan, provision of circular designs, and re-use of circular projects" (Rijkswaterstaat, 2021). To formulate and reach same targets, identifying and incorporating the lessons learnt from pilots done by this consortium and other external parties, is considered with high importance by the tactical level of the Municipality. Also for conducting circular projects various procurement paths are recommended by the "Netherlands National Raw Material Agreement" as well (Government of the Netherlands , 2016) .

Circular projects are innovative and sustainable. Hence ambitions within both paths should be integrated in developing a procurement procedure for circular projects. According to the internal document DH9, based on sustainability path, tasks like integrating circular design principles (such as detachability, extending life span, and re-use) in projects, and collaboration with other public organizations and governments should be implemented. Based on the innovative path, the circularity transition is one of the main themes for the Municipality, including tasks of providing a wise and extensive market search and asking for consultation from expert market parties. In case of large project scale or existence of large risks, division into different lots, longer project durations, and more flexible contracts are desirable. Based on the internal document DH9, best tender procedures recognized by municipality for these projects are; competitive dialogue, innovation partnership and procedures with negotiations.

3.2.3. Re-use strategy at tactical level of Municipality of Den Haag

Existing information regarding re-use strategy within the tactical level of the municipality is mostly the result of researches of the other public client organizations like Rijkswaterstaat on the re-use topic. The main task for tactical actors in 'Sustainability Knowledge Team' of municipality is customizing these inputs and providing internal documents for re-use projects. According to the advisory document provided by the Rijkswaterstaat, using reclaimed materials for same target, other function and dividing them into different elements to use later, should have three first priorities in projects respectively (Rijkswaterstaat, 2023). According to (Rijkswaterstaat, 2023), some important tasks should be done in development of re-use projects namely: "evaluation of re-use potential of materials, identify and deal with re-use dilemmas and

uncertainties, development of specific organizational structures for implementing re-use projects, and Defining new roles for re-use within current work procedures" (Rijkswaterstaat, 2023). The important tasks in development of re-use projects are mentioned in the Table 3.2, based on Rijkswaterstaat, (2023). In general, in implementation of the re-use projects, the most important thing to consider is adjustment of commissioning and management method and in general organizational aspects, instead of reaching the highest technical level, according to Rijkswaterstaat, (2023).

Table 3.2. Important tasks in development of re-use projects, recommended by the Rijkswaterstaat

No	Important tasks in development of re-use projects	Suggestions
1	Evaluation of re-use potential of materials	• Testing the elements against specific technical indicators like detachability of component and component's level of standardization, desired re-use level within project; "re-use for as is function or different function", potential amount of reclaimed materials in the project, financial feasibility • Listing the potential materials for re-use by project teams as material inventories
2	Identify and deal with re-use dilemmas and uncertainties	• Being aware of the general uncertainties in re-use projects including: Risk distribution between involved actors, the issue of ownership of reclaimed materials, provision of storage system, project's control system, balancing the supply and demand of reclaimed materials, financial benefits and costs in re-use projects and steering of procedure • Formulate specific solutions to deal with them prior than initiation phase
3	Development of specific organizational structures for implementing re-use projects	• Formulation and implementation of novel project management methods, make correct choices and provide the context for re-use properly • Adjusting the organizational structures in public client organizations for re-use and making the re-use procedure the normal model of infrastructure development • Adjusting the way of collaborating with market parties in specific, using two methods: 1. Organizing considering type of components: • Let it be organized by market parties, and jus provide pre-requisites in case the market is more mature • Organizing everything within public organization: make connection between supply and demand and organize everything in-house in case of lack of experience by contractor parties or requirement of making specific decisions within the project • Participate within coalitions between public client organizations or governments, for steering re-use projects 2. Organizing by "explicit concentration on re-use and implementing organizational wide actions" including: • Formulating specific business model to concentrate explicitly on re-use, providing and integrating more compatible design principles with re-use, adopting work procedures, aesthetic requirements and technical issues, dedicating long time durations for adopting the principals, dedicating budgets
4	Defining new roles for re-use within current work procedures in public organizations	• Defining new steering and advising roles in regards to integrate re-se practices into current work procedures of the organization and conducting required new tasks: 1.Internal ambassador as top advisors (tactical level): structural management for re-use; formulating requirements, internal regulations for conducting re-use within projects, etc. 2. External ambassador (operational level): checking internal work procedures with re-use theme and integrating new ideas from external organizations/Collaborating in experiments and pilot projects aimed for investigating methods to conduct re-use procedures in operational level. 3. Innovative managers (tactical & operational level): Integrating the knowledge and experiences gained from pilots and experiments in the work procedures, manuals and guidelines for design, and adopt them for re-use projects.

3.3. Operational level of the municipality in conducting re-use projects

In this section, the operational level of the municipality is investigated. All different operational procedures such as procurement, execution of projects and pilots, design procedures, etc. are explored in terms of compatibility with re-use strategy and explained in sub-sections below. Just like in investigation of tactical level, the general approach of sustainability, the circularity and re-use strategy are zoomed in consecutively.

3.3.1. Putting sustainability themes into practice

Implementation of the different sustainability themes in projects at the operational level of the Municipality of Den Haag, is currently based on the procedure of "Sustainability Scan" (The Hague , 2019). This procedure consists of an initial meeting called the sustainability "Brainstorming session", to formulate the project's sustainability ambitions based on the strategies extracted from sustainability agreements, and project's opportunities. Based on the internal documents DH7, DH8 & DH10, the participants in these brainstorming sessions are project team and actors from the sustainability knowledge team. With sustainability scans, project teams can find out the sustainability themes which will be followed during the projects and the affects they will have on the sustainability transition, and result of the project. In conducting sustainability scans, consultation with related administrative role and conducting periodic evaluations at the end of each project phase is required to check the outcomes and make revisions on ambitions (The Hague , 2019). The required stages in conducting sustainable projects is explained in the next sub-sections.

a. Conducting sustainability scan with Ambition Webs (GWW)

The Sustainability Ambition Web of "GWW" is used as a substantial tool for conducting sustainability scan in projects (The Hague , 2019). According to the internal documents DH10 & DH13; ambition web should be completed in 4stages. Stage A includes defining the desired level of realization for each specific ambition. In the second stage (B), the feasibility of attached level to each ambition should be checked. In the stage C, recognized ambition levels should define as concise (quantitative) performance indicators, which can be more general in initial steps of projects. In the stage D, the final ambition levels should be recorded with explanations on each sustainability theme. Appendix B.3, illustrates one GWW ambition web. 3 different levels can be defined for each ambition. The Level 1 represents commitment to a minimum levels of sustainability. The second level represents desire to reach a considerable progress in regards to the sustainability performance. And the last level implied on eliminating all negative effects and putting maximum level of efforts to reach the target. To accelerate the sustainability and circularity transitions, reaching the third level is crucial.

b. Developing participation & communication plan in projects with sustainability ambitions

Beside formulation of ambition web, providing communication plan is also required in conducting projects with sustainability themes. Based on existing communication plan document of DH14, Den Haag has its own method, with 4 different phases of the participation plan, participation analysis, participation design, and formulating the report. These participation plans are mostly with the aim of involving the ideas of stakeholders into the design procedure of project, and needs dedicating of specific budget, time and expertise. The existing plan has been formulated during the final stage of sketch design phase. Hence the plan is not practical enough since the initiation phase had been missed, and the plan is passive. Moreover, the formulated document is just an exploration on different participation options, and more detailed participation stages are required as well.

c. Conducting sustainability scan for Sustainable material use theme

Considering 'material use' as one of the recognized sustainability themes by the Municipality of Den Haag, they are different ambitions to formulate in the GWW with different levels. Some ambitions within material use theme are incompatible with each other, and more focus is required in management of these targets within projects. According to the internal document DH11, there are two sub-themes in sustainable use of materials namely; control the quality and quantity of material consumption (including targets like; re-use, recycle and assuring longer lifecycle), and control the used material's greenhouse emission or social aspect in procedure of production, transfer and implementation of materials. For the control targets, some helpful indicators& tools which are considered to be used by the municipality of Den Haag within development of ambition webs, are explained in the Table 3.3, based on the internal document DH11.

Table 3.3. Sustainable material use indicators

Material use indicators & measurement tools	Explanation
The Material flow indicator	The required amount of recycled materials in new products and projects
The MKI indicator	Cost of environmental impact in all stages of project's lifecycle (can be measured using the DuboCalc[5] tool)
The Life Cycle Analysis (LCA)[6]	Illustrating the greenhouse emission amount of materials during their lifecycle (Using DuboCalc)
The material value	The monitory value of materials

According to the internal document DH11, each of these indicators are targeted to be used in reaching different ambition levels. In the first level, since the minimum sustainability level should be reached, only information regarding sustainable specifications of materials like re-usability, maintenance conditions and environmental impacts of them should be provided. Also, minimum measures like reducing the emissions, longer lifespan, and material use by some circular strategies are targeted to be conducted in this level. In the second level sustainability measures will be more considerable, by implementing use of the tools and indicators like MKI, calculation through DuboCalc tool & LCA. Targets in this level are minimizing environmental impacts, material use & cost of lifecycle, implementing modular and detachable construction, more re-use and use of materials from re-newable sources. In the third level, the main target is reaching a stage with fully circular material use and the most important indicator which is used in this level is the MKI. The third level is aimed to provide added value to the project as well. According to the internal document DH11 & DH13, within the Municipality of Den Haag, currently only the second level of ambitions are formulated for theme of material use, to be reached in projects. Implementation of circularity within projects as a sub-theme of the sustainable material use in the municipality of Den Haag, is explained in detail in the next sub-section which also includes implementation of re-use strategy.

3.3.2. Putting circularity approach and re-use strategy into practice

Currently the circularity ambitions are mostly followed by pilot projects within the Municipality of Den Haag. For accelerating re-use transition, it is very crucial to start performing, learn by doing and involving the gathered lessons from practice (like pilot projects) into the normal work procedures within the public client organizations. One pilot commissioned by the municipality organization is explained in the next sub-sections based on the internal document DH15 & DH17. The most crucial aspects in implementing the circular strategies like re-use within in the municipality, are mentioned as lessons learnt from this pilot as

[5] DuboCalc: https://www.dubocalc.nl/
[6] The Life Cycle Analysis (LCA): https://www.rivm.nl/en/life-cycle-assessment-lca

well. The aim of this pilot was investigating the possibility of operationalization of circular strategies in regards to materials such as "re-use & dispose", in renovation of the quay walls. In this project, the current situation of the quay walls and their components has been investigated with aim of exploring possibilities within project to conduct a high-quality re-use. Provision of a material/ waste inventory, and onsite re-use were also aimed within this projects. This pilot is elaborated in this sub-section.

a. The pilot procedure

Some stages which have been followed in this pilot is illustrated in the Figure 3.4. The main focus within this project was procurement and design phases of circular projects with strategies like, material re-use, and dispose. Followed stages can be used as a blue-print in future projects with same strategies as well.

Figure 3.4. Followed stages in the circular pilot of quay walls (Retrieved from internal document: DH17)

According to the internal document DH15, the ambition web of this pilot is formulated in 2018 with target of making a point of reference for comparing the ambition webs in the future stages of the project, and follow up the results, which has not done yet. The ambition web of this pilot is indicated in the Figure 3.5. This ambition web is only designed for the design phase of project and tender phase. Within this pilot project some specific barriers have been identified which can be prevented in the future pilots and real projects with same circularity theme, by formulating and implementing more detailed advisory documents at tactical level. Among these barriers, one is very important to be prevented in the future. In the stage of collecting municipality's ambitions to develop the award criteria for working with the Rapid Circular Procurement (RCC) method, there was a lack of a coherent group of actors to participate in all sessions.

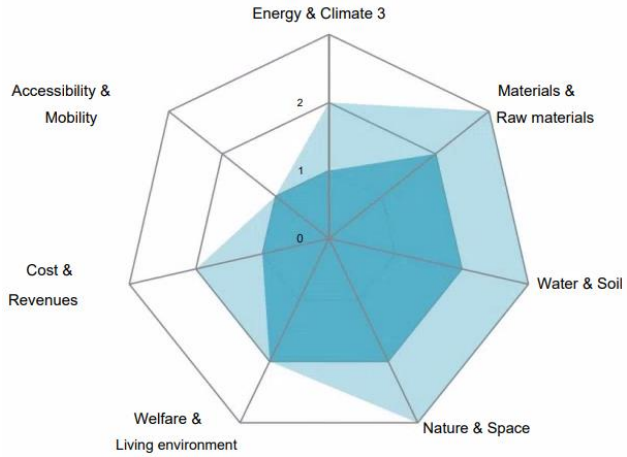

Figure 3.5. Ambition Web of the pilot project of quay walls (retrieved from internal document: DH15)

As a result, extra time dedicated on describing the RCC method and previous information for new actors attended in each session. Also, in same stage, internal barriers within the Municipality have been identified including: incompatibility of RCC with policy documents, and lack of acceptance of stakeholders to proceed with this method. This barrier identified as result of works of municipality's internal project team and RCC support team (K Plus V)[7]. The RCC method is elaborated more in the next sub-section.

[7] K plus V is the company who developed the RCC innovative procurement method: https://www.kplusv.nl/oplossingen/circulair-impactvol-en-innovatiegericht-inkopen/

b. Advises formulated based on the result of pilot

Based on the internal document DH17, 6 advices have been formulated by pilot team on result of the pilot to be implemented in circular and re-use projects. The Municipality is suggested by project team to integrate these advices into its policy to produce specific circularity policy and develop these projects in the future, which has not done yet in practice. Based on the internal document DH18, the 6 advices are formulated as follows: 1. formulating of specific tender strategy for circular projects based on project's specifications and scope, such as the RCC method. 2.formulating circularity design assessment frameworks "considering circularity targets", 3.investigating different methods with "specific indicators" for assessment of circularity level, 4.integrating the material cost indicator (MKI) considerations in the manuals (through "conducting measurement of all products, define a ceiling to move towards minimum MKI"), and 5.formulating policies on "design freedom scope", interactively and based on manuals within the municipality like Handbook of Public Places (HOR)[8]. Among all formulated policy advices within this pilot project, the suggested tender strategy of RCC is recognized as a significant requirement to implement circular projects. The RCC method has been suggested by the consultancy company involved within the quay walls pilot project as a good choice to put circular projects and specifically re-use procedures into practice. This procurement method is specifically formulated for joint efforts and collaborations with market parties in defining the circular solutions in projects. In the process of implementing the RCC strategy, some important hints should be accompanied as well to assure the quality of work procedures. These hints are mentioned briefly in the Appendix B.4. There is no follow up document on implementing this method and suggestions in other projects within the municipality.

c. Advices on organizational culture

It is mentioned by the pilot team in the internal document DH17, that in such transitions, systematic changes in the culture of the organization should be occurred. Presence of a Circular Transition Team (CTT) within organization is important in reaching the transition targets. According to the project documents, the circular transition team had been made up, including different actors within the municipality and trained by the external team to implement the RCC method. Such 'change agents', should conduct periodic progress assessment within the municipality through implementing their experiences. Some elements have been recognized by project team based on Kotter's Model (Pollak , 2014), as crucial components to make this cultural transformation successful, namely; provision of the sense of urgency, defining clear vision, develop a steering coalition, developing a clear communication pattern, providing preconditions for change, providing short term targets, and monitoring the progress (Pollak , 2014). However, in the pilot the most important obstacle was cultural, including: periodic confusion among internal actors, stemmed from a gap between created vision, action plan and dedicated project's resources. Formulated advices in this field are: High motivation and strength from steering coalition to conserve the defined circularity ambitions and conduct the project team constantly, a clear vision formulated by the steering coalition from the early stages with constant follow-ups in different phases, and constant support for project team.

d. The released Material inventory from pilot project

According to the internal document DH16, as result of this pilot a material inventory has been provided through two main methods of *Desk research* and *On-site investigation*, implemented by pilot team.

[8] Handbook of public places (HOR) is the main manual used within the Municipality of Den Haag, including all design and technical standards for development of high quality infrastructures and public spaces. https://www.denhaag.nl/nl/in-de-stad/wonen-en-bouwen/ontwikkelingen-in-de-stad/handboek-openbare-ruimte-.htm

Drawings from different parts of the quay wall project and its components reviewed in the desk research. Based on the provided information by the municipality it was revealed that there is a lack of information regarding the technical specifications of used material (lack of a complete material passport), detailed maintenance plan and implemented repair works on each component. In the on-site assessment phase; the main tasks were gathering information regarding the used material in the project, project's site, maintenance situation, and quality level of elements, possibility of deconstruction, detachability and re-use. Materials investigated based on aesthetic values, economic aspects, and quality level. In case an element was not appropriate for re-use, it considered as subject for recycle. Within the provided inventory some specifications are mentioned for each material including: component's serial number, location, quantity, size, category of component, products with repair accompanied by level of wastes, pollution, and strength level. The inventory provided for restricted number of materials due to restricted scope of this project.

e. Pilot project's limitation and follow-up procedures within the Municipality

In this pilot project the re-use of material was the main target. However, due to the risk of collapse of the quay wall the circularity section of the pilot project left in the half of the project and only the renewing of the quay walls has been followed with regular work procedure. Hence the implementation of the Suggested tender procedure (RCC), and releasing the circular and reuse targets of the pilot project was not possible. To accelerate the re-use and circular transition, some suggestions have been formulated from inside the municipality of Den Haag which are listed in the Table 3.4, based on the internal document DH18.

Table 3.4. Internal Advices of Municipality from result of the pilot

No.	Advices
1	Involvement of external expert parties in design phase
2	Provide opportunities to implement re-use in research oriented projects with concentration on circularity instead of regular project targets
3	Assure the availability of adequate budget from a general circularity program
4	Selection of contractor based on compatibility of their expertise with the certain circularity strategy of the projects
5	Create an informed, skilled and motivated support team for project to collaborate with technical team
6	Prevent testing circular opportunities in projects with complex inherent (high timely and monitory pressures) which will affect the quality of project and do not provide valid results for the pilot

In general, various useful actions have been suggested by the external actors and municipalities' advisors on the result of this pilot. However, no document in operational level is revealed the implementation of result of this pilot in other projects, or existence of other project with re-use focus. Even the ambition web from the other project phases of this pilot are not available to be used for evaluation of targets and apparently not even formulated. Moreover, the result of project and the advisory document has not completely spread throughout the organization and mostly is restricted to the department of project team which cannot be helpful for future projects. In the next section a comparison between tactical and operational level in implementation of re-use project is conducted to provide the answer of the research question in this chapter.

3.4. Comparison between the two levels

After reviewing the documents at the two organizational levels of tactical and operational, regarding implementation of re-use strategy, a comparison is conducted in this section. The aim is to recognize the possible gaps or links between levels. To conduct each comparison procedure a point of reference is required. To formulate this point of reference, important considerations in implementing re-use projects identified from reviewed documents at both levels. The important considerations are listed and existence of them in documents within both levels have been checked, within the Table 3.5. The listed considerations, are put under 8 important categories in implementation of circular projects (see Table 2.1). The link between

levels can be recognized, if the consideration is not only mentioned within internal/external policy documents, advisory documents and agreements at tactical level but also in the internal pilot and project documents at operational level. Moreover, within operational level, each consideration should be identified not only in the documents from initiation phase but also the realization phase of projects. Lastly, if a consideration is only implemented and tested within operational level, and not mentioned in the tactical documents, it cannot be used as bases for future projects to accelerate the transition which will cause gap. Each consideration that have not found in all tactical and operational *Internal documents*, identified as a field of gap between the two levels. The identified fields of gap from this comparison are listed separately in the conclusion section.

Table 3.5. Comparison between tactical and operational level based on the gathered important considerations in implementing re-use projects

Categories	**Important considerations in implementing re-use projects**	**Documents From the Tactical Level**			**Documents From the Operational Level**	
		Internal; policy documents	External; policy documents/agreements	External; results of external research and pilots	Internal; project/pilot initiation phase /advisory document	Internal; project/ pilot realization phase
Re-use knowledge, expertise and experiences	Gathering knowledge and skills to deal with general uncertainties and dilemmas such as: incompatible project targets with sustainable theme of minimizing material use	✓	–	✓	✓	–
	Integrating lessons learnt from pilot projects into the normal work procedures within the organization/provide required information flow	–	–	✓	✓	–
	Conducting pilot projects with wide scope to include inspection on all material types	–	–	✓	✓	–
Organizational procedures and structures	Existence of a definite project procedure/framework to implement in pilots and reuse projects to assure project success and gather reliable results	✓	–	–	✓	–
	Defining transition teams (“change agents”) with main tasks of: monitoring transition procedures- formulating indicators, checking material flows and dynamics within transition process	–	✓	✓	✓	–
	Defining new internal/external expert actors and innovators to carry out new tasks in re-use projects	–	✓	✓	✓	–
Culture, behavior and communication	Tracking the progress and realization of re-use ambitions, with a coherent information flow and periodic evaluations	–	–	✓	✓	–
	Creating adoptable organizational culture and work procedure, to make systematic changes and reach the targets of re-use transitions	✓	✓	✓	–	–
	Holding collaborative & interactive brainstorming session: Formulating sustainability ambitions at the beginning of procedure	✓	–	✓	✓	✓

	Formulating detailed participation & communication plan from the initial phase of project to gather stakeholders ideas actively	–	–	–	✓	–
Technics and technologies for re-use, technical feasibility	Providing required detailed material specifications within projects for material inventories (technical specifications, maintenance plan, damages, etc.)	–	✓	✓	✓	–
	Measuring the components re-use potential & providing material inventories for re-use targets	✓	–	✓	✓	✓
	Formulation of re-use ambitions within the third level of GWW ambition web	–	–	✓	✓	–
	Implementing "material use" indicators within projects	✓	–	✓	✓	✓
Re-use support practices and requirements	Considering extra time frames for re-use pilot	✓	–	–	✓	–
	Formulating and implementing intra-organizational re-use advices and guidelines for future projects	–	–	✓	✓	–
Collaboration with market and supply chain	Involvement of market parties for re-use	–	✓	–	–	–
	Need for site to site re-use; determining specific projects with potentials for re-use	–	✓	–	–	–
Contracts, manuals and guidelines	Use of integrated collaboration model/ project delivery model for re-use based on project's specifications	–	✓	–	–	–
	Implementing integrated RCC procurement method in circular projects with re-use approach	–	–	✓	✓	–
	Formulating and implementing the principles and indicators of design for re-use explicitly	–	✓	✓	–	–
Financial aspect and support	Conducting pilots with low level of complexities, and less financial risks to make the project doable and provide reliable results	✓	–	–	✓	–

3.5. Conclusion and next steps

In this chapter different documents at tactical and operational level of the municipality on implementation of re-use strategy have been reviewed, such as: the external sustainability and circularity policy documents, agreements, re-use advisory documents, internal policy documents at tactical level and internal advisory documents and project documents at operational level. Through conducting a comparison procedure between reviewed documents at tactical and operational level, the fields of link and distinction between the two levels in implementing re-use strategy have been identified. This comparison conducted based on important considerations in implementing re-use projects, extracted from all reviewed. Each consideration that have not found in all tactical and operational *Internal documents*, identified as a field of gap. In general, there were not many operational documents on the realization phases of pilot/projects with re-use strategy, which revealed the fact that implementation of this strategy at operational level, is not that much mature and systematically organized. Moreover, the link between the two levels is very weak, and they are more fields of gap between the two levels than links. Full link only existed in the 3 fields of: *implementing re-use indicators within projects, measuring the component's re-use potential*, and *formulating sustainability*

ambitions at the beginning of projects. In some cases, the information is just stocked at the tactical level and not translated properly for operational actors like as in guidelines. On the other hand, the result of circularity pilot at operational level has not transferred properly to the tactical level, thus there is no coherent document for future projects formulated by the tactical level. This example itself addressed different gaps from category of 'communication, culture and behavior between the two levels', such as 'lack of a coherent information flow'. Another gap between these levels is identified in comparison of documents from different phase of projects at operational level, namely; initiation and realization. For instance, the ambition webs of circularity pilot project and other project with sustainability themes are only exist from the initiation phase. There is no ambition web from other stages of projects to make comparison between them and follow-up the targets. This example addresses the gap in 'evaluation and follow-up' field, which is a necessary factor in implementation of innovative targets, like re-use. Table 3.6, indicates all identified gaps in practice in implementation of re-use strategy, between tactical and operational level. The identified gaps resulted from the comparison in section 3.4., represented in the Table 3.5 and categorized under the 8 important categories (see Table 2.1).

Table 3.6. Identified gaps in practice between tactical and operational level in implementing re-use strategy

Categories	Identified gaps
Re-use knowledge expertise & experiences	- Lack of knowledge and expertise to deal with uncertainties within re-use projects - Gap in conducting pilots with proper scale and learning from pilots
Technics and technologies for re-use/Technical feasibility	-Lack of detailed material specifications within all projects and general material inventories (technical specifications, maintenance plan, damages, etc.) - Gap in implementation of ambition webs at operational level
Re-use support practices and requirements	-Time constraints for re-use/pilot projects - No clear re-use specific support provided for the operational level
Contract, manuals and guidelines	-Incompatible procurement methods and contract models within re-use projects; still use of traditional method instead of circular methods like RCC - Formulation of guidelines on re-use - Compatibility of provided design at operational level with strategy at tactical level (lack of design principles)
Organizational procedures and structures	-Lack of a specific work procedure/project stages to be implemented in the pilot/projects with re-use theme and gather more validated results -Lack of explicit roles with re-use expertise, to implement and follow up re-use projects/ Fragmented sections and teams active on re-use
Culture, behavior and communications	- Lack of clear target formulation & consistent follow-up/evaluation procedures on re-use targets and ambition webs -Lack of consistent communication & stakeholder engagement plans from project initiation phase -Lack of coherent information flow within and between the two levels -Lack of an adoptable organizational culture to make systematic changes in transitions
Collaboration with market and supply chain	- Lack of involvement of market parties for re-use -Gap in linking the supply and demand & low availability of re-usable materials
Financial aspects and supports	-High financial risks as result of complexities within pilot projects

To prevent the issue of subjectivity in identification of gaps, and prioritizing the gaps to identify the most urgent ones, it is needed to check the links and distinctions between the two levels by practitioners as well. Hence, the gaps between levels will also be investigated in the next stage of the research through conducting a round of semi-structured interviews. Interviewees will be asked to prioritize the category of gaps based on their experiences with re-use projects. Moreover, existence of the identified gaps will be asked from interviewees through open questions, to gather more concrete and reliable results for gap identification stage. The provided list of gaps (Table3.6), will be used in formulating the interview questions. At the end the gaps will be prioritized through qualitative analysis method, to find the most urgent gaps.

Chapter 4:

Semi-structured interviews

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CHAPTER 4: SEMI-STRUCTURED INTERVIEWS

This chapter is continuing the empirical study phase of research and is aimed to provide practical insights into the research. The main contribution of this chapter is validating and complementing the formulated results from the two previous chapters, and making foundations of the final framework. By conducting semi-structured interviews, the SRQ4 is answered in this chapter, which is formulated as follows:

SRQ 4: What enablers and barriers can be identified to deal with the most important gaps between tactical and operational level in implementing the re-use projects?

The stages conducted in this chapter are represented in different sections as follows: Section 4.1 is providing some information on the whole methodology of collecting data with the semi-structured interviews. Section 4.2 is representing the procedure followed for selection of the interviewees. Section 4.3. includes the formulated interview protocol, which is followed by indication of procedure of analyzing the gathered data in the section 4.4. Section 4.5 represents some explanations on the current situation in practice with re-use transition and main specification of re-use projects, followed by the identified important fields of gap in practice between the tactical and operational levels, represented in the section 4.6. In the section 4.7. the most important enablers & barriers in implementing re-use projects, potential for dealing with the identified important gaps provided, followed by linking them and elaborating their relevance in the section 4.8. The conclusion of this chapter and gathered recommendations from interviewees to fill the important gaps, and the next steps of the research, are provided in the section 4.9.

4.1. Data collection

In this section the conducted round of semi-structured interviews is explained as second part of the empirical phase of this research.

4.1.1. The method & purpose

To validate the gathered result from theoretical phase and continue the empirical phase, the gathered information from literature reviews and document reviews, used as inputs for the interview phase. Since the research has an intra-organizational approach towards an immature topic (re-use of materials), investigation of different practitioner's ideas within the questioned organization found highly useful. The "Semi Structured Interview (SSI)", is implied on an interview method which includes a mix of questions with answers varied in length, in which occasionally the responses will be continued by some other questions formulating at the moment (Adams, 2015). This method is beneficial, since provides the opportunity of "more in depth" discussions with the practitioners on the novel topics like re-use and lets managing the "direction of discussion" better (Ruslin et al.,2022).

Linking the two organizational levels of tactical and operational and accelerating implementation of re-use projects requires zooming into the both levels, as well as identifying the existing gaps between them. Relevant to each field of gap, there might be some barriers which caused that gap or can maximize it. Relevant enablers on the other hand, can have important roles in overcoming or mitigating the barriers, which can consequently help to fill the gap, if you know how to implement them and extract advantages from them. Hence, to be able to deal with the gaps, the first step is identifying the enablers and barriers relevant to each gap, which was the main aim of the conducted interviews in this phase. Through semi-structured interviews the important fields of gap between the two levels in implementing re-use projects, identified and prioritized. Also, important enablers and barriers relevant to each gap identified, and linked

to the gaps. These links will have fundamental role in formulation of the final framework. Also, provided recommendations by interviewees, represented at the end of this chapter, will be used in formulating solutions for filling each gap in the next chapter.

4.2 Selection of interviewees

This research has an accurate focus on the gap between the two levels of tactical and operational within the municipality of Den Haag as a public client organization, in implementing the re-use strategy. Hence, it was needed to zoom into each of the two levels separately within interviews and investigating dealing with re-use strategy in each level (just like the used method in document review phase). The logic in selection of interviewees was twofold, which are as follows:

1. Inviting same number of interviewees from each of the two organizational levels, to be able to go in depth in investigation of each level equally.
2. Inviting interviewees with at least one experience with projects including sustainability and circularity targets like re-use, to be able to provide required inputs for research.

As also mentioned during the document review phase, there are fragmented tactical and operational sectors, and teams active on sustainability topics, in different departments of this organization. Also some people are somehow working in both levels, like internal commissioners. Hence operational and tactical interviewees recognized in different ways. First of all, most of the actors within the group of "Sustainability Knowledge Team" of the organization (see section 3.2.1.) invited. Since the structure of this team were fragmented between different departments around the municipality, exact organizational level of each role have been also asked within the interview questions. Then, some other practitioners with advisory or steering roles, which are completely tactical, have also been invited to the interviews. Also, same number of operational actors, like project managers, technical managers, technical engineers and designers, invited to the interview sessions. The list of selected practitioners for interviews is presented in the Table 4.1. To make an anonymized reference point for each interviewee's phrase throughout the chapter, each actor is identified by a specific code as well. For municipality employees the code is defined by DH letter as abbreviation of Den Haag, combined by a specific number for each interviewee. The organizational levels in which the actors are placed, defined by different letters of T, O or TO implied on tactical, operational and Tactical & operational respectively. For the external actors which are supplier & contractor, the abbreviation of SC is dedicated, with the interviewee's numbers.

Table 4.1. List of selected practitioners for interviews

Category of interviewees	Dedicated code	Exact role	Organizational department	Type of carried tasks	Years of experiences
Tactical Actors within the Municipality	DHT1	Member of Design team and sustainability knowledge team	DSB: IBDH department	Tactical & operational	20
	DHT2	Coordinator of the construction team & internal commissioner	DSB: asset management department	Tactical & operational	14
	DHT3	Circular economy advisor	DSB: Policy department	Tactical	7
	DHT4	Sustainability advisor	DSB: System mobility department	Tactical/strategic	17
	DHT5	Executive advisor of public spaces and infrastructures	DPZ: General Affairs	Tactical/operational/strategic	6
	DHT6	Internal communication advisor	DSB	Tactical	15
Tactical & operational actors	DHTO 1	Procurement advisor	DBV: Procurement department	Tactical	5
	DHTO 2	Project manager	DSB/IBDH	Tactical/operational	6

Within the Municipality	DHTO 3	Project manager	DSB/IBDH	Operational	20
	DHTO 4	Landscape architect	IBDH	Tactical & operational	13
	DHTO 5	Technical manager	IBDH	Tactical & operational	36
Operational actors within the Municipality	DHO1	Project manager/involved renovation program	DSB/IBDH	Operational	12
	DHO2	External Project manager	DSB/IBDH	Operational	8
	DHO3	Structural engineer	DSB/IBDH	Operational	25
	DHO4	Engineer	DSB/IBDH	Operational	10
	DHO5	Stakeholder engager	DSB/IBDH	Operational	10
Re-use contractors and suppliers	SC1	Project coordinator	External actor	External actor	8
	SC2	Project advisor	External actor	External actor	26

4.3. Formulated interview protocol

In general, 18 interviews have been conducted for this phase. The first stage of the interviews where identification of actors informed by re-use practices, with different roles and organizational levels. After identification of each actor, a preliminary search has been conducted on the actor's specific role, main tasks and relevant department. All actors have been invited to the interview sessions via email, which contained an explanation on the topic and the attachment of the informed consent form. The interviewees asked to fill and sign the forms in case of being fully agreed on the conditions of interview, and send them back before start of each interview session. The interviews have been developed based on the provided Semi-structured list of questions and some other questions also came up and asked at the moment in each interview session.

At the begging of each interview session, the interviewee informed by the main idea of the research, interview phase, and also the specific concepts used within the questions like tactical & operational level. Each interview lasted around 60 minutes. The detailed interview protocol is attached to the Appendix C.1, contains the list of questions and the interview themes. The questions started with explaining interviewees roles, years of experience, and their organizational departments and levels, which was important for the aim of this research. The interview sessions followed by questions formulated under 4 main themes, including: general expert opinions on re-use projects, enablers and barriers for re-use, existing links and distinctions (gaps) between tactical and operational level, and also recommendations from practitioners to link the two levels and implement more re-use projects. The themes formulated based on the results and also main areas in the previous chapters. For the theme enablers and barriers specifically, interviewees received the list of enablers and barriers from literature review phase, to rank them based on their level of importance.

4.4. Data analysis procedure

Qualitative analysis, is the best data analysis method for researches with goals like "defining" elements, "categorizing", prioritizing and shortlisting, which are main targets in this phase as well (Ruslin et al., 2022). For qualitative analysis, different methods can be used for each certain "research question", and even methods can be combined and used to answer same question (Ruslin et al., 2022). Analysis of the data gathered in this empirical stage, were qualitative, including analysis of the answers on open questions, through coding in Atlas.ti data analysis software (Atlas.ti, 2023). Specifically, for the theme enablers and barriers, a combined method used, including: ranking the list of enablers and barriers gathered from literature review phase, on top of analyzing the answers on open questions through software. Within the analysis procedure the anonymized transcripts put in the software and different codes dedicated to the quotations of interviewees. As an illustration, the interviewee DHO4 said: "*now it's more flexible with*

young people who have different mindset, but other people say we do not re-use, while its more urgent now", which coded as; *current sense of urgency for re-use in young generation*. Also interviewee SC1*"* mentioned: *"contractor has more knowledge about reusable themes",* which labeled by the code of *using high knowledge on contractor side in re-use*. In general, 132 codes formulated in this analysis stage. Figure 4.1 represented a group of codes formulated for some quotations. Quotations from anonymized transcripts, relevant to the themes *general expert opinions* and *links & distinctions between levels* are represented in the Appendix C.2, under their relevant codes.

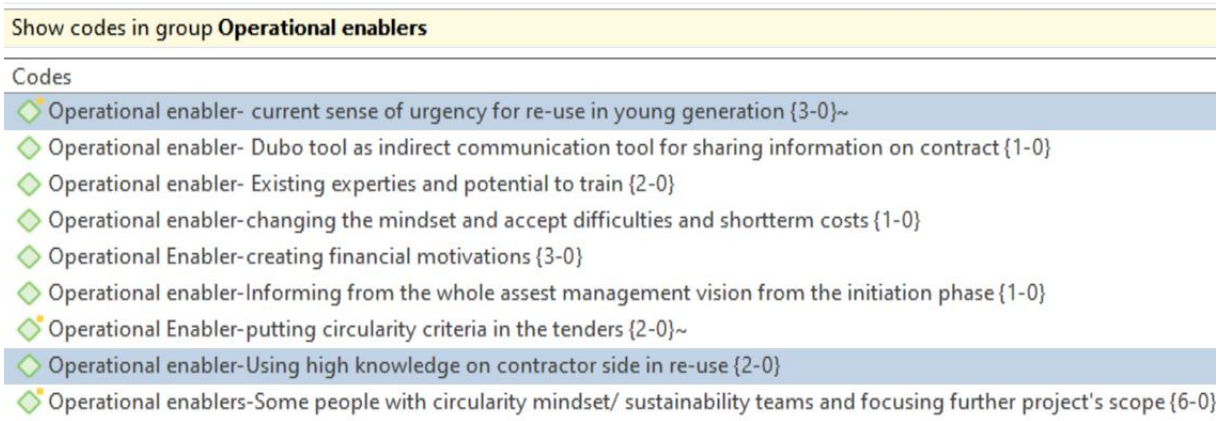

Figure 4.1 Screen shot of dedicated cods to the quotations (Retrieved from the Atlas.ti software)

The codes provided and assigned to the quotations using two different methods. With the first method which called "deductive", the codes developed in line with the results and terminologies released from the previous chapters of the research (Linnenberg & Korsgaard , 2019), like different categories of gap. With the second coding method, which called "inductive", the codes developed based on the interviewees quotes provided under each theme (Linnenberg & Korsgaard , 2019), such as; some enablers and barriers mentioned by interviewees, recommendations and re-use specifications. The codes put under 17 Code Groups, which was the tool in the Atlas.ti software to categorize codes. The Code Groups identified based on the interview themes and also some themes divided into different Groups. The aim of this action was providing more clear results and analyzing the data accurately. For instance, there was a theme for links and distinctions between tactical and operational level, which divided into 8 different Groups (based on categories in Table 2.1), indicating different categories of gaps among two levels such as knowledge or financial aspects. Also the theme of enablers and barriers divided into 6 Groups based on the level in each the specific enablers and barriers have been recognized; 3 groups of operational, tactical, operational & tactical enablers and 3 groups of barriers with same respect. Also for the theme of the general expert's opinions regarding re-use projects, the two groups of *general current situation with re-use* and *re-use main stages/elements* are assigned based on the answers provided by the interviewees. In the coding procedure, the links between the two levels considered same as enablers for re-use projects. Figure 4.2, indicates the formulated Code Groups, retrieved from Atlas.ti software.

Code Groups	
Distinctions between levels- Category of Re-use knowledge, experties & experiences	(2)
Distinctions between levels- Category of collaboration with market & supply chain	(2)
Distinctions between levels- Category of Contracts, manuals & guidelines	(4)
Distinctions between levels- Category of culture,behavior and communication	(6)
Distinctions between levels- Category of Organizational procedures and structures	(2)
Distinctions between levels- Category of Re-use support practices and requirements	(2)
Distinctions between levels- Category of Technics and technologies for re-use, technical feasibility	(2)
Distinctions between levels- Category of financial aspects and supports	(1)
General current situation with re-use	(8)
Operational barriers	(8)
Operational enablers	(10)
Re-use main stages/elements	(5)
Recommendations for implementing more re-use projects and linking the two levels	(38)
Tactical and operational barrier	(8)
Tactical and operational enabler	(13)
Tactical barrier	(7)
Tactical enablers	(14)

Figure 4.2 Screen shot of Formulated Code Groups for analyzed data (Retrieved from the Atlas.ti software)

For indication of relevance between code groups and their underneath codes a *Group Network* is illustrated in the Figure 4.3 as an example, which is belonged to the Code Group of *"Distinction between levels- of culture, behavior and communication".* The Group Network is a tool within Atlas.ti software that indicates different codes within each group separately (Atlas.ti, 2023), and help to analyze the codes under each group easier. Result of analysis of data belonged to each code group are elaborated in the next sections.

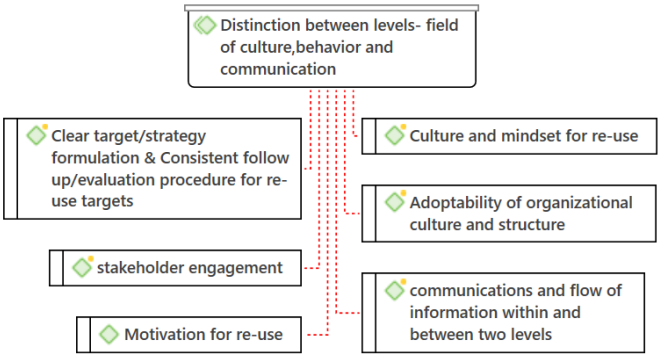

Figure 4.3. Group Network of "Distinction between levels- category of culture, behavior and communication" (Retrieved from the Atlas.ti software)

4.5. Re-use transition and projects

To gather general information on situation with re-use transition in practice and approach of experts towards the concept of re-use, 2 general questions have been formulated under the *general expert's opinions* theme. The result of data analysis in this theme is presented in the next two sub-sections.

4.5.1. Current situation with re-use transition

According to the interviewee SC2, "*within the last 4/5 years, municipalities are much more aware of benefits of using secondary materials because of the international goals".* Hence re-use is more common in the recent years. Existence of successful projects and reviewing them can be very helpful in being motivated for re-use, and conduct more projects with this strategy. However, the number of successful re-use prototypes is very low and few materials like natural stones and pavement bricks are being re-used within infrastructure sector. Currently they are too much resistance to re-use within the sector, and products are only going to be re-used if they are *"good in shape"* according to DHO3. Also according to

the interviewee SC1: in current situation *"higher knowledge and experience is on the contractor side"* in implementing re-use projects, which is bolding the need for outsourcing some parts of re-use projects like design, as mentioned by DHO2.

4.5.2. Main stages & specifications of re-use projects

Re-use project is mostly addressed as innovation by practitioners. There are some stages or specifications within these projects which make them distinguished from projects done by virgin materials. Firstly, the reclaimed materials cannot transfer to the under construction projects directly, since they "*have dirt and they are varying in shapes"*, hence *cleansing of dirt and adjustment of shapes"* can be known as extra stages within these projects, as mentioned by DHT1 & DHO4. As a result, there is always high cost of project in total with implementation of re-use strategy, such as *costs of transactions among the wide network* involved within project as mentioned by DHT4, and costs of transportation & storage. Moreover, according to DHO3:" *we have mostly re-use in maintenance and not new designs and concepts".* However, it is experienced that involvement of re-use strategy from initiation and design phase is important. According to DHTO2: "*at the beginning they are high ambitions for re-use but later the project team drop the targets"*, due to low quality of materials, and "*guarantee of material quality*" is very important in these projects according to DHT3.

4.6. Most important fields of gap between tactical & operational level

Next, the interviewees asked to address their opinions regarding distinctions and links among tactical and operational level in implementing re-use projects. The questions were formulated in open format & also based on the fields of gaps gathered from document reviews (see Table 3.6). Most of the answers, verified existence of high distinctions between the two levels, in most of the fields addressed in the result of document reviews. Gathered distinctions categorized under 8 different *Code Groups*, based on the categories mentioned within the literature review and document review phases (see Table 2.1 & 3.6). The aim of formulating questions in this theme was identifying most important gaps existing within the municipality between the tactical and operational level with accurate priorities, which is required for solution making procedure. The most important fields of gap between the two levels represented within the Figure 4.4, based on gathered result of data analysis from the Atlas.ti software. These gaps selected and prioritized based on the frequency that gap mentioned by interviewees. Each gap should be mentioned by at least half of the interviewees (9) to be recognized as most important. Important gaps which are elaborated in the next sub-sections, are 10 in general and belonged to 5 categories.

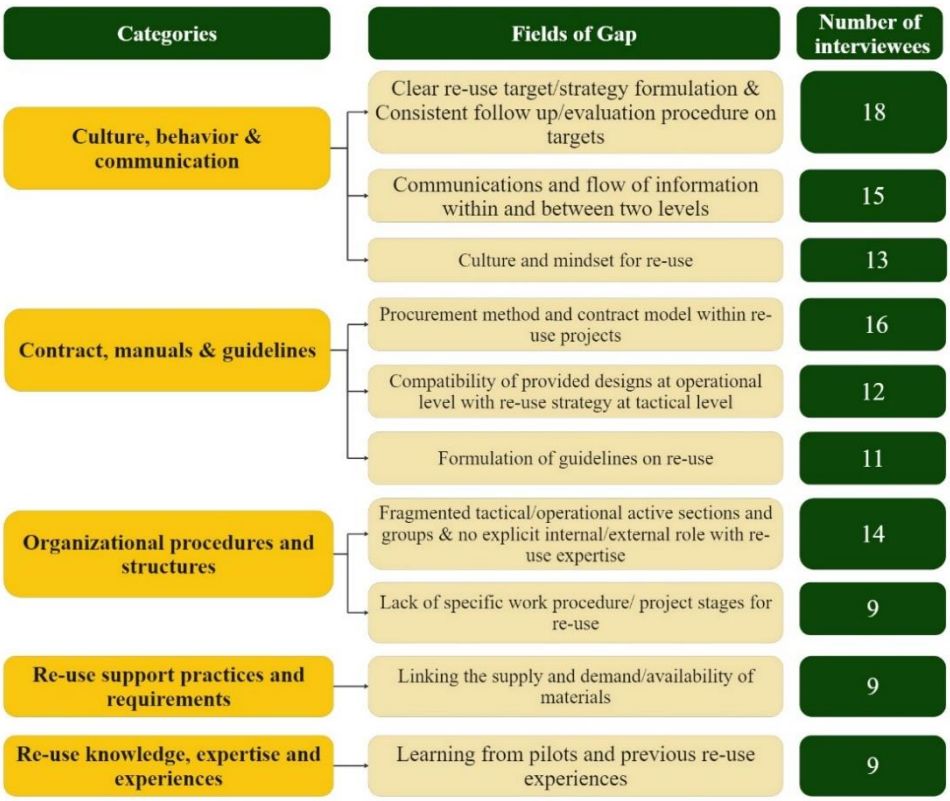

Figure 4.4. The most important fields of gap between the operational and tactical levels in implementation of re-use projects

4.6.1. Gaps in organizational culture, communication and behavior

- ***Clear re-use target/strategy formulation & consistent follow-up/evaluation procedures on targets***

As mentioned by most of the interviewees there is no accurate numerical target and clear re-use strategies for projects at operational level of municipality. According to DHT5," *if you do not translate the general goal to the operational level, it will never be reached"*. There is only the general target of what can be re-used should be re-used and what can be recycle should be recycled in contracts, without a *"clear percentage for re-use"* according to DHT2. Also, the targets are only implemented at operational level in working with few materials. Even the general vision is not clear for all actors at operational level. Within few projects, some sub-targets are formulating which are not clear enough, and not consistent in all projects. As mentioned by DHT1*:" we do a sustainability scan (formulating the GWW ambition web) at the start of every project and then we see if there is a logical sub-target to be made for this project"*. According to interviewees, there is no coherent follow-up procedure on re-use sub-targets or evaluation and reflection on them within different stages of projects or among the two tactical and operational level. According to DHTO2: "*at the beginning of projects the goals are very high but when you get in the realization the less is happen"*. The procedure of formulating GWW webs contains stages of *formulating goals and follow-up on targets* according to DHT1. However, there is no periodic monitoring or formulation of report on the GWWs for evaluating them in projects yet, which can prevent to reach the formulated sub-targets.

- ***Communication and flow of information within and between two levels***

In field of implementing the re-use strategy, there is no mature information system yet, and the flow of information between different levels of the organization should be more clear. According to DHTO2*" there is not such coherent flow"* within the organization for re-use practices, specifically, in terms of sharing

result of pilot projects which have effective role in learning procedures. Evaluating result of pilots, transferring them to the tactical level and making advices on what can be done to improve way of works at operational level are required to be done to make a good flow of information, according to DHO2. However, according to DHT3:" *the result of pilots are only shared in a small public, and not from operational to tactical level* ", and this small public incliuding project team and internal clients according to DHO1& DHTO1. As recognized during the interviewes, the roels which were not close to the pilot groups, were not really aware of the pilots at all, which is a sign of existance of a gap in filed of information flow. To use lessons learnt from pilots there should be consistent reflections and reports on them. There is no "*orgenized reporting system on re-use projects for follow-up" according to DHT5*. Also, this lack of information flow is not only internal but also felt between different actors like contrators, suppliers and clients. External actors are parts of operational level in doing projects, hence the flow of information should be activated also among different project actors. The flow of information should also be implimented through communications. Mostly there is no consistent communication plan with external parties. According to SC2*:* there is a big gap in "*bringing contractor and supplier together and try to have same goals for the project"*. There are mostly separate communication procedures and not between all 3 parties at same time.

- ***Culture and mindset for re-use***

About the mindset and organizational culture for re-use within municipality, there is a high gap. As mentioned by DHO1:" *in the pilot on re-use there were a lot of resistance within the team".* This resistance and gap in culture have two reasons. First, people within the municipality tend to use new materials since they cannot trust the quality of reclaimed ones, and according to DHT2: "*people feel more comfortable with something new"* so they easily refuse using second hand materials. Second, there is a need for a big change and integrating extra stages in work procedures for these projects and according to DHTO1:" *Processes and procedures are always adaptable", h*owever, people in the municipality tend to continue with the way of working which they used to follow. Organizational culture is not flexible enough in the municipality, which make it very time consuming to implement such changes.

4.6.2. Gaps in re-use knowledge, experiences and expertise

- ***Learning from pilots and previous re-use experiences***

Currently in the infrastructure sector the re-use transition is still at the beginning and there are only few (successful) pilot and project experiences with that. Also as mentioned by DHTO4 re-use activities is restricted to few materials like "*tile stones and bricks in roads".* Also, the efforts are not aimed for re-use and there are not that much structured pilots for re-use, as DHT3 mentioned taht: *"there were just projects that we initiated with re-usable materials".*

- ***Explicit internal or external re-use specific roles***

Currently there is no explicit roles like ambassadors for re-use and some people do that beside their main roles, like people within the *Sustainability Knowledge Team*, according to the interviewees. It recognized that this combination of roles and not having them in explicit may affect their activeness in re-use field. and as DHO2 mentioned*: "that would be really better if you make some people really responsible for it".* Since the roles were not explicit enough, even some of interviewees were not familiar with existence of such roles so they could not have practical interactions and exchange of ideas. Even as mentioned by interviewees, the role of innovation manager is also very rare in the organization, and not that much active and recognizable within the municipality. Also, according to DHTO4, and DHO1, "*collaboration with external ambassadors for re-use just occurred once and has not repeated yet, since was very costly"*.

4.6.3. Gaps in contracts, manuals and guidelines

- ***Compatibility of provided designs at operational level with re-use strategy at tactical level***

As mentioned by interviewees like DHT1, DHT4 & DHTO5: In general, *"there is not strict& explicit guideline and structure"* for designers to implement the re-use design principles. There are only design criteria in working with external designers. According to DHTO1*:"sometimes municipality set kinds of criteria that designers should consider re-use within the desin".* According to DHT2*: "only on the tactical level we are beginning to become aware of such principles, so its really low level of maturity".* As mentioned by interviewee DHTO4, it is required to impliment principles that also make the design durable and compatible for on site re-use with minimum adjustments.

- ***Formulation of guidelines on re-use***

As mentioned by almost all interviewees there is no specific guideline to implement re-use within the operational level, and experiences are mostly based on the *"common sense"*, according to DHTO4 . According to DHO1 only "*the tactical level says re-use what you can"*without speciifc guidance, which is easily ignorable by project teams. To prevent that, formulation of a strict action plan as guideline which is mandatory to impliment, is required as also mentioned by DHTO2. The DHT5 as a tactical actor mentioned: *"The most imporant gap is translating the policy".*According to DHTO1, such guidelines can be developed using reflections on result of pilots, to define clear steps and structure for impliemnting re-use.

- ***Procurement and contract model***

As mentioned by most of the intevirwees the procurement and contract delivery model followed in re-use projects are mostly traditional. The municipality only hand out the project to contractor after providing the design, based on the best price-quality, and some certain criteria for re-use. These criteria are very basic which have to be exceeded by the biders in tender, as mentioned by DHT5. Integgrated contracts are sometimes used only for involving contractors for more years like for maintence stage of project according to interviewees. In terms of necessity of using innovative and integrated models, DHO1 mentioend:" *innovations can be done with the market and municipality can not do them alone so we have to find collaborators".* According to DHTO4*: "if you need a knowledge of contractor, its better to give that design to the contractor, if he has smarter ideas".* Most of interviewees were not familier with innovative methods like RCC, or they only heard about that, since it just used once. Implimentation of RCC had two problems. Firstly, according to DHO1, "*should be implimented from design phase, which will restrict the work of in-house designers".* Secondly, according to DHT2*: "the pilot of RCC had problem with structural safety"*and did not continued. But according to interviewees, implimentation of RCC can be for sure helpful for conducting re-use projects, which should be first tested again in another pilot with compatibl scope.

4.6.4. Gaps in organizational procedures and structures

- ***Fragmented tactical and operational active sections and groups within departments***

The tactical and operational sections and teams active on circularity are very fragmented within this organization. According to DHT2: "*the DSB has its own tactical team of "sustainability knowledge team" and also the urban planning department have focus groups on circualrity issues".* There are active colleagues on re-use within both DSB and DSO, and re-use is discussed in small groups in these departmant, which are not connected together. In other departmants like DBV and DPZ, there are also roles active on circularity and re-use topic, with supportive tactical role and operational role respectively.

- ***Lack of specific work procedure for re-use***

According to interviewees DHO3 & DHT4, re-use activities are done in normal work procedures without any specific and coherent structure. Also as mentioned by the contractor party SC2, this traditional way of doing re-use projects, is not appreciated by them and there is nothing formulated in specific for these projects. The main procedure which should be followed in re-use projects is that; the re-use activity should be fit with approaches in the asset management departments and 'Handbook of Public Places' (the HOR), and if not, it will not be implemented at all. Also, according to SC2; checking the project with the "MKI indicator" is also some sort of specific stage within the work procedures in these projects. So there are some fragmented stages to follow but nothing customized to deduct the hustle in re-use projects.

4.6.5 Gaps in re-use support practices and requirements

- ***Linking the supply and demand/availability of materials***

As mentioned earlier in this chapter, existence of a complete storage system is the main requirement for implementing re-use projects. According to DHO4:*" We have no space to store and we need big open storage for a lot of material exist in the street to store them up for long time"*. It is not only about place, but also providing a complete system with organized administrations and data base is required, like as DHT2 mentioned:" *You need to make some sort of exchange by creating a showroom and catalogue and say we have so many meters of this material, with certain quality*".

4.7. Important enablers and barriers for implementing re-use projects

After identification of the important gaps, it is required to also identify the enablers and barriers which are relevant to deal with the recognized gaps. In this regard, first the important enablers and barriers for implementing re-use projects have been gathered and represented in general through two different methods. Each of these methods are explained within below sub-sections. The identified important enablers and barriers from each method, shortlisted based on their relevance to the top 5 categories of gap, and added together. The collected important enablers and barriers identified as potential ones to deal with the top 10 gaps, and relevance between them will be explained in the last section.

4.7.1. Ranking List of Enablers and barriers from literatures

Under the theme of enablers and barriers, the interviewees asked for ranking a list of enablers and barriers. The list sent to them in a format similar to a survey to better manage the interview time and let them to be more focused by the ranking activity. The list sent to them with a Likert scale, and asked them to rank the provided enablers and barriers in terms of their level of importance for implementing re-use projects. Likert scale is a tool for gathering and evaluating different ideas on a topic, scientifically (Joshi et al., 2015). The respondents also asked to add the missing barriers and enablers, to the list. Since the research topic has a specific focus on the two different organizational levels of tactical and operational, the tactical and operational enablers and barriers have been defined in the list. Since not everyone was informed by enablers and barriers from both levels, two separate tables provided for actors in each level. Moreover, for enablers and barriers which was shared between levels, the column of *tactical & operational* added to both tables. The data from Likert scale can be analyzed qualitatively using various methods like "median, frequency of responses (mod), average", etc. (Bozonelos , 2020). The best method is different for each scale and is "related to the type of data", which is normally "Ordinal or Interval" (Piccolo & Lannario , 2008) . "Ordinal data" is data which focused on "Ordinal value such as rating, evaluation, preference scores, etc." and accurate numbers "between scale ranks" are "meaningless" for them (Piccolo & Lannario , 2008). The gathered data in this study is level of importance, which is also a sort of "Ordinal data" and "best method

for analyzing such data is calculating the Mode & Frequency" of responses (Joshi, Kale, Chandel, & Pal, 2015). This survey provided with a 4 rank scale including; 1. not important 2. somewhat important 3. quite important 4. very important. The aim of providing a 4 rank scale instead of 2rank of important & not important, was preventing interviewees to simply tick various elements as not important and eliminating range of enabler/barriers which are required to deal with some specific gaps. With using 'Mode' or the most frequent responses as method for analysis, the list from literature review shortlisted properly into 25 barriers and 24 enablers. In cases of existence of two modes for one element, the median of modes considered for analyzing that specific element, since "Median" is second valid method for "analyzing ordinal data" (Joshi et al., 2015). Only 16 lists have been filled and sent back by interviewees for doing analysis, since 2 of interviewees were not available to fill the survey due to summer vacations period.

The result of analysis of all ranked lists provided by interviewees, represented in a table within Appendix C.3. The barriers & enablers with modes between 3 to 4 (range between quiet and very important), which are also under same categories as important gaps, considered as shortlisted ones, which are potential to deal with the top 10 gaps, and depicted in the Figures 4.5, and 4.6 respectively.

Apart from ranking the provided enablers and barriers some interviewees mentioned other enablers and barriers for implementing re-use projects which were missed in the lists. These enablers and barriers gathered and presented within the Table 4.2. This table have been added into the enablers& barriers mentioned by interviewees. Each added enabler or barrier mentioned by an interviewee, put into the transcript of the same interviewee and analyzed qualitatively with the other data, by Atlas.ti software.

Table 4.2. Missing enablers and barriers added into the survey by some interviewees

Level	Enabler/barrier	Interviewee code
Tactical barrier	Lack of standards on technical quality and lifecycle specifications of reclaimed and re-used materials	DHT1
	Lack of knowledge on market situation/development	DHT5
Operational barrier	Lack of knowledge on how to start with re-use	DHO1
Tactical and operational barrier	Lack of (nearby) facilities to clean and prepare reclaimed materials	DHT1
Operational enabler	Create a business case that shows a re-use project provides more value than a regular project	DHO1
	Finance the extra costs through a subsidy of re-use projects	DHO1
Tactical and operational enabler	You need the organization that has embraced the topic of re-use	DHTO3
	The financial and economic aspects may never be leading in design of infrastructures	DHTO3
	Overseeing the impact of not making designs with re-use materials	DHTO3
	Re-use storage space	DHTO4

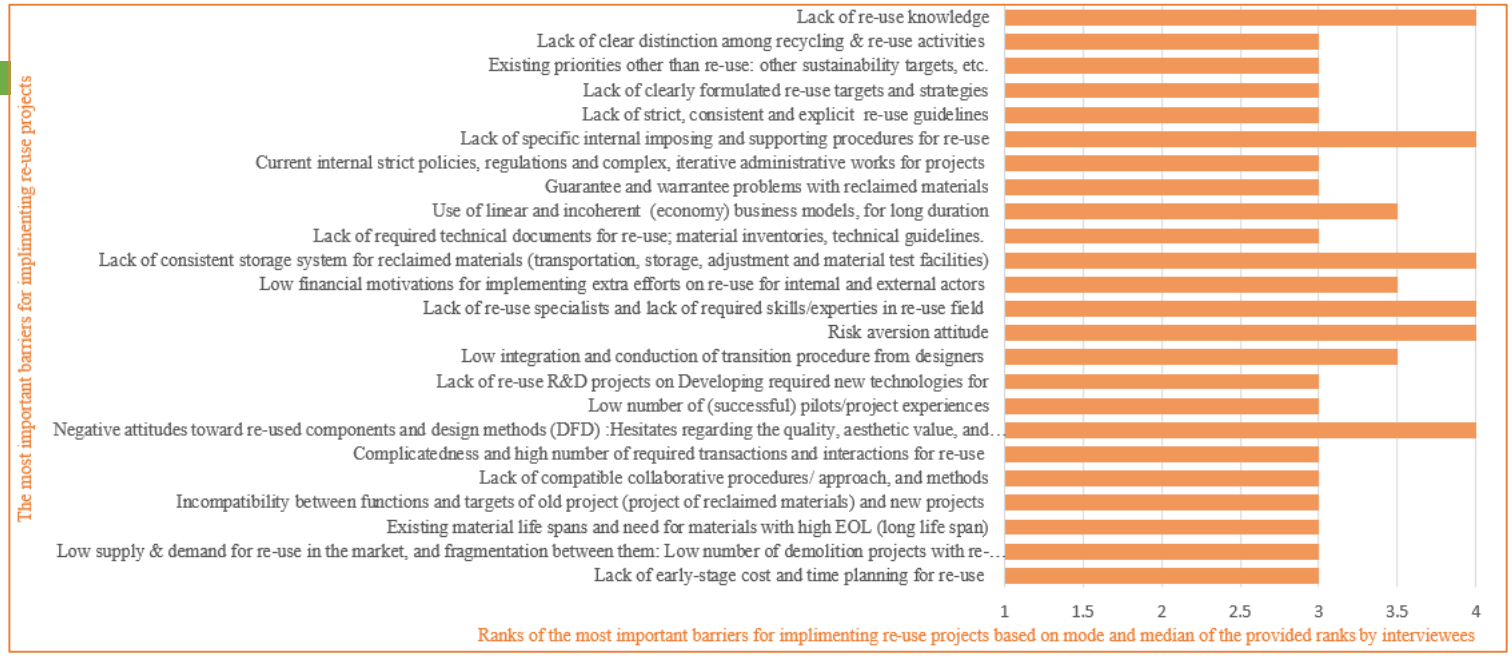

Figure 4.5. Most important barriers ranked by interviewees, relevant to categories of top 10 gaps

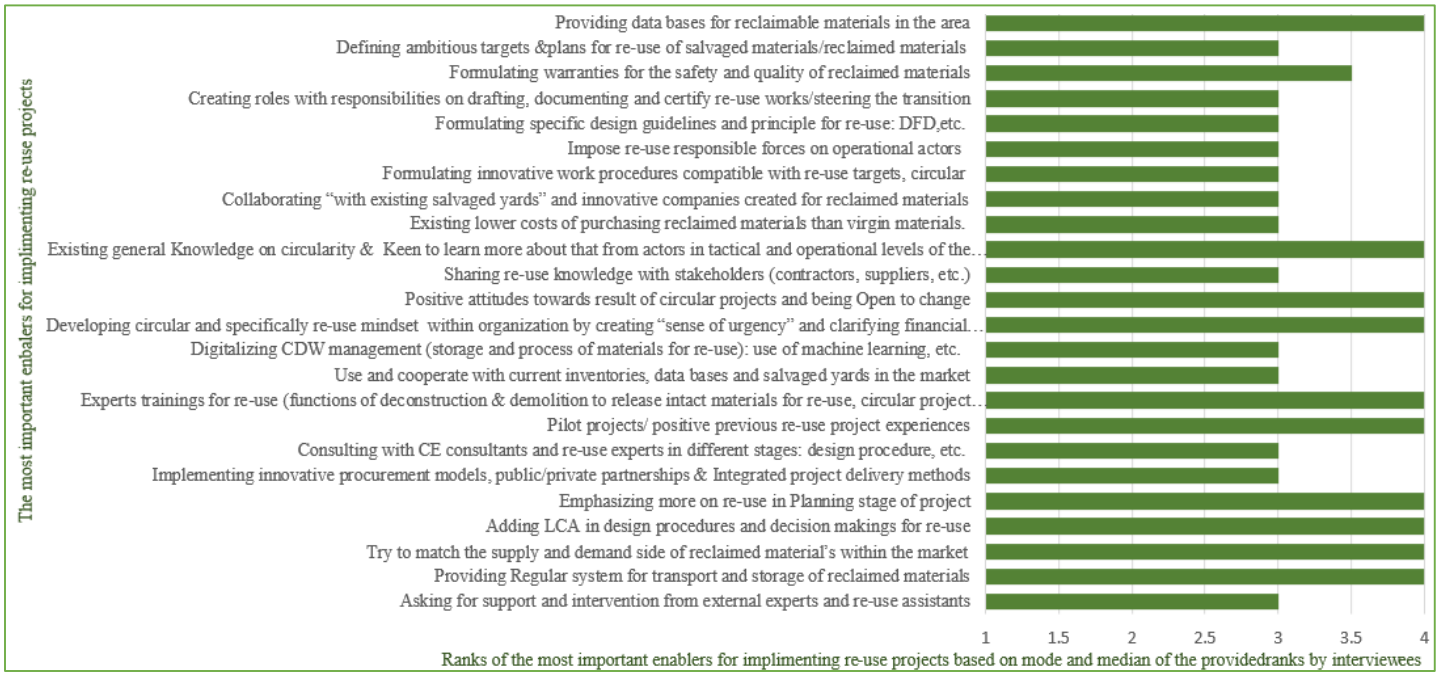

Figure 4.6. Most important Enablers ranked by interviewees, relevant to categories of top 10 gaps

4.7.2. Enablers and barriers based on the interviews

The interviewees were also asked by open questions to mention enablers and barriers during the interview sessions. Also, they asked for pointing these enablers and barriers as tactical or operational. The gathered answers have been analyzed and coded with Atlas.ti software (Atlas.ti, 2023), and the codes categorized under six groups based on the relevant organizational level to the enablers and barriers, namely: *tactical barriers, operational barriers* and *tactical & operational barriers*, *tactical enabler*s, *operational enablers* and *tactical & operational enablers*. The enablers and barriers considered as important ones if they mentioned at list by 2 interviewees, and were relevant to the top 5 categories of gaps, mentioned in the Figure 4.4. All enablers and barriers gathered from interview questions are listed in the AppendixC.4, with the total number of interviewees mentioned that enabler/barrier, which retrieved from Atlas.ti data analysis software. All relevant barriers and enablers to the important categories of gaps, which mentioned frequently by interviewees, are listed in the Table 4.3 as important ones, based on interviewee's quotations. Relevant quotes to the enablers and barriers and explanations on them, are presented in the Appendix C.5 & Appendix C.6 Respectively.

Table 4.3. List of important enablers and barriers from interviews

Barriers	Level	Frequency	Enablers	Level	Frequency
Complicatedness and required high number of transactions and interactions	Tactical	3	Existing expertise and potential to train	operational	2
Existing priorities other than re-use: other sustainability targets & and conflict of work procedures with other targets	Operational	2	Developing re-use mindset & creating sense of urgency for re-use	Tactical	2
Extensive time of projects and lack of early stage time planning	Operational	4	Using high knowledge on contractor side in re-use	Operational	2
Current internal restricting rules within manuals like handbook of public places to work with reclaimed materials and complex iterative administrative works	Tactical	3	Some people with circularity mindset/ sustainability teams and focusing on further project's scope	Operational	5
Lack of a consistent in house storage place/system (adjustment, transportation, storage) for reclaimed materials	Operational	3	Providing regular (in-house) storage system with digital CDW management and data bases and explore opportunities in the area	Tactical & operational	3
Required high quality materials, certain specifications and high technical standards for maintenance	Tactical & operational	3	Formulating specific design guidelines and principles and implementing them	Tactical & operational	3
low number of demolition project with re-usable elements, incompatibility between functions and targets of reclaimed	Operational	2	Lessons learnt from counterpart organizations	Tactical & Operational e	2
Risk aversion attitude and resistance to change from all internal and external	Operational	8	spread knowledge and experiences to the other level & more communication efforts	Tactical & operational	2
Lack of compatible collaborative procedures / Existence of traditional method and approach; Single contracts & Cost driven tenders	Tactical & operational	2	use of reclaimed components from other public organizations in design	Tactical & operational	2
Lack of re-use mindset	Tactical	2	Make the network of re-use more clear	Tactical	2

Negative attitudes & cultural resistance towards re-used components and design methods like DFD, hesitates regarding quality and durability	Tactical & operational	2	Obligation to re-use from internal client side	Tactical	2
Guarantee and warrantee problems	Tactical & operational	3	Testing/implementing re-use within programs to enhance learning process	Tactical	2
Lack of clearly formulated re-use target and strategies	Tactical	3	creation of more rooms and liberties within internal manuals, and decrease bureaucracies	Tactical	2
			Existing attention from public clients to sustainability and agreements & documents and forcing to implementing sustainability scan	Tactical	7
			current sense of urgency for re-use in young generation	Operational	2
			Putting circularity criteria in tenders	Operational	2
			Complete implementations of existing sustainability target formulation framework (GWW)	Tactical	7
			spread knowledge and experiences to the other level & more communication efforts	Tactical & operational	2
			apply the existing handbook of public places as guideline in operational level and consistent revision of that	Tactical & operational	2
			Existing general "sustainability knowledge team" and internal advisors active on re-use	Tactical & operational	4
			existing regulations for recalculating and extending lifetime	Tactical	2

The important enablers and barriers to deal with the gaps under the top 5 categories, gathered from both survey and interview open questions and represented separately in this sub-section. In the next section, gathered enablers and barriers from both methods are added together and relevant enablers and barriers to deal with the top 10 gaps selected from them. The links between the selected enablers and barriers and their relevant gaps are elaborated in the next section.

4.8. Linked important enablers, barriers & gaps

The barriers addressed to deal with each gap is identified based on the potential of the barriers in creating that gap or making that more critical. The enablers however are recognized based on their potential to overcome or mitigating the addressed barriers and consequently filling the gaps. The relevance between the selected enablers, barriers and how they can contribute to deal with their linked gaps are explained for each gap separately in the next sub-sections.

4.8.1. Communication and flow of information within and between the two levels

The *complicatedness and required high number of transactions and interactions* can be addressed as a barrier in re-use projects, which can make the communication stages very hard at project level, among internal and external actors. As a result, there will be less consistent information flow among the project

team, and consequently the information will not send to the tactical level intact. With defected or low quality information received by tactical actors, there will be defected feedbacks and advices formulated back to the operational actors. One enabler which can deal with this barrier can be *spread the knowledge and expertise to the other level & more communication*. Also, by clarifying the existing knowledge at tactical level on how to deal with complexities within re-use projects, for the operational actors, the transactions can be better planned from initiation phase. Also, existence of such flow from operational to tactical level can help to share the real experiences and expertise at project level with the tactical actors to provide better clue for them about how is the complexities in implementing the strategies and targets.

4.8.2. Re-use target /strategy formulation & consistent follow-up on targets

The Lack of clear distinction among recycling and re-use activities, is one important barrier which created the gap in target and strategy formulation. Such general vision allowed the organization to easily continue without formulation of any concrete strategy or target on re-use. The gap in field of target and strategy is not only about lack of existence of targets but also about lack of *clarity of them.* Using the general prescription of re-use as much as possible cannot be recognized as a useful strategy to reach the re-use targets. Defining some *more ambitious targets and plans for re-use* on tactical level and *implementing the existing target formulation method (the GWW) completely*, are enablers which can solve the problems with target formulation & follow up. Also, other *sustainable priorities* existing from the beginning or evolves among the projects, like minimizing the CO2 emission in transport of materials, can make *conflict with re-use targets* and prevent actors to continue with them. To prevent actors to drop the targets, the enabler of *creating roles with responsibilities on drafting, documenting and certify re-use works* can be helpful. These actors, will also force project actors to provide follow up ambition webs (GWW) in each stage consistently. Lastly, the *re-use responsible force* should be imposed on operational actors by internal clients to make the project actors provide information on released targets and follow-up them.

4.8.3. Culture and mindset for re-use

The risk aversion attitude and resistance to change, is one main barrier for evolving of re-use culture within organization. Implementation of innovations like re-use requires certain level of flexibility to make systematic changes. Also, the risk of using second hand materials should be accepted at first place and then planned to be mitigated, which is against risk averse attitude. Also, it is very hard to ask people to implement re-use strategy, who *do not have this mindset* and are not believe in the advantages and *urgency* of that. Sometimes, there is not only lack of the re-use mindset, but also *negative attitudes* like *hesitates regarding quality of re-used components and new design methods,* which is another barrier that can hinder the re-use culture in the organization. Since these barriers are rooted in mindset of people, dealing with them should be more spontaneous. Dealing with *resistance to change* can be solved by *creating sense of urgency*, and *involving young generation* who already have this sense of urgency and are more open. These people can also spread the sense of urgency among other actors, and influence them. *Clarifying financial advantages and values of re-use for actors,* can also be beneficial. If people know financial benefits of re-use in long-term and its other values, like minimizing the CO2 footprint and costs, they will have less resistance, and less fear regarding financial risks. One other potential enabler is *more involving the people with circularity mindset and focusing further project scope*. These people are already informed about value of reclaimed materials, and re-use design principles like DFD, methods for assuring the quality of materials, and have less resistance. Such actors in any project team, can focus further project scope (time, budget& quality), and can push the team to consider the sustainability aspects, and affect their attitudes in long-term.

4.8.4. Compatibility of provided designs at operational level with re-use strategy at tactical level

Existing material life spans and need for materials with higher EOL is one barrier which addressed the gap between designs and re-use strategy at tactical level. Designing with re-use targets can be very hard or impossible with short life spans of materials, and further calculations are needed to compensate the short life spans by the design (Rijkswaterstaat, 2021). One enabler which can be implemented is *adding the lifecycle analysis in design procedures and other regulations for recalculating and extending the components lifecycles*. Another barrier which address this gap is *low integration and conduction of the circularity transition by design team.* Without proactive involvement of designers in implementation of re-use strategy, design principles cannot be implemented and checked. *Formulating design guidelines and principles like DFD by tactical level* and *Emphasizing more on re-use in planning stages of projects* at operational level, will lead to more proactive involvement of designers in the re-use procedure. This way the designers will bind themselves to implement re-use principles in designs and check the design until execution phase to be compatible with the principles.

4.8.5. Formulation of guidelines on re-use

Within the field of guidelines, one important barrier is lack of a *consistent and explicit guideline for re-use.* By general guidance like re-use as much as possible, this strategy cannot be implemented well, and it should be more concise. Also there is barrier of *guarantee and warrantee problems with reclaimed materials*, within strict material use manuals, which should be overcome by formulating specific guidelines on re-use. To overcome both barriers, *applying the Handbook of Public Places with consistent revision of that* is suggested as a useful enabler. By periodic re-visioning stages in HOR, problems with the guarantee and warrantee can be solved and a consistent re-use manual can be provided based on this main manual. Also, by forcing the operational actors to implement sustainability scan within all projects based on *existing attentions toward sustainability and signed agreements*, more clear rout or guideline can be developed for operational actors to follow. Without *clear technical guide or material inventories*, practitioners do not have any clue to how start with this approach and re-use what materials. However, there are *some technical manuals on specifications of restricted number of materials.* Using these manuals accurately and try to provide them for more materials can be a helpful enabler for dealing with the addressed barrier.

4.8.6. Procurement methods and contract models within re-use projects

Existence of the *traditional, cost driven contracts* for implementing re-use projects addresses the gap in the field procurement and contract models. Using traditional methods, do not let the organization to procure best form of contract to implement all requirements of re-use projects. To mitigate the effect of such barrier, the *re-use criteria can be formulated concisely and put in the tenders*. This way the requirements can be meet even with *single contracts*. General criteria, like re-use as much as possible or mitigate the CO2 emission as much as possible cannot be very useful. The other barrier is *lack of compatible collaborative procedures for re-use,* and not dealing with that can extend the gap in procurement. *Implementing more innovative and integrated methods like public-private partnerships or RCC*, can be recognized as an enabler in this regard. Integrated and circularity procurement methods assure the success within re-use projects since they can create more room for collaborations and interactions among broad network in these projects.

4.8.7. Learning from pilots and previous experiences

With *very low number of successful pilot/project experiences with re-use targets*, there will be no consistent lesson which can be implemented in all type of projects. One relevant enabler to deal with this barrier is *focusing on lessons learnt from few previous internal experiences and pilot projects done by the counterpart organizations on re-use strategy.* If the number of pilots are low, complete analysis of them and extracting lessons and processing them to make practical steps for future project can also be helpful. Not various pilots should be done by each public client, and most of the time same lessons will be extracted from pilots done by other clients, which prevent investing budgets or dedicating time. *Implementing re-use within programs* can also enhance quality of learning process, while re-use will be implemented within lots of projects with different specifications and more lessons and experiences will be gained from them.

4.8.8. Fragmented tactical active teams and no explicit internal/external re-use experts.

Lack of explicit and focused re-use specialists & required skills for re-use, make people in different fields to try hard to formulate required tactical procedures and implement them within projects, which will cause the fragmentation of activities. One relevant enabler to deal with that is use of *existing expertise and potential to train among operational and tactical level*, to enhance the level of re-use skills within organization. Moreover, some external experts can be involved, who have higher level of knowledge on re-use. *Asking for support and intervention from external CE consultants and re-use experts and contractors* is another enabler which address this requirement. Also, focusing on *the general sustainability knowledge team, internal advisors and active actors on re-use,* and try to make one integrated network active on re-use clearly and explicitly, can be helpful to overcome the mentioned barrier.

4.8.9. Specific work procedures/project stages for re-use

Use of linear and incoherent business model for re-use for long duration, made this believe among some actors that the re-use can be implemented by normal procedures, and circular models are not necessary. This barrier can be overcome by *formulating innovative work procedures compatible with re-use targets* which are non-linear and customized for re-use activities. The *extensive time of projects and lack of early stage time planning* also addresses lack of specific required stages for re-use. *Emphasizing more on re-use from initiation phase* can consider as one re-use specific project stage which should be implemented to overcome mentioned barrier. Lastly *Current internal restricting rules within manuals for working with reclaimed materials and complex iterative administrative works for projects* prevent to make specific procedures for re-use projects. With creation of more liberties within manuals, innovative procedures can be implemented and followed to reach circularity targets.

4.8.10. Linking the supply and demand/availability of materials

In re-use, *quality of materials, technical standards and certain specifications,* should be assured for maintenance in future. Asking for these specifications of materials is barrier to easily implement re-use projects and cause a gap in field of availability of re-usable materials. In terms of quantity of available materials and demand for them, the barrier of *low number of demolition projects with re-usable materials and low demand for re-usable materials* is existing. Also, *lack of consistent storage system for storing, transferring and adjusting the re-usable materials* cause the gap in linking the both sides of supply of reclaimed materials and demand for re-usable materials. *Using and collaborating with existing systems like, current data bases, salvage yards and other public organizations* and only conducting a supportive role can be a way to overcome barriers in this field. The public client can also implement *a regular in-house storage*

system with digital CDW management, which will help the municipality to explore re-use opportunities within area and also link the supply and demand.

4.9. The chapter conclusion & gathered Recommendations for next steps

In this chapter, through conducting a round of semi-structured interviews and qualitative analysis, most important fields of gaps between tactical and operational level of the municipality in implementing re-use projects identified and prioritized. Also, important enablers & barriers in implementing re-use projects shortlisted, and linked to the important gaps. The aim in this chapter was identifying the relevant enablers and barriers to deal with the most important gaps in practice and provide a base for filling the gaps and formulating solutions in the next chapter. To reach this target, first fields of gaps between two levels gathered from result of the interviews and the most repeated gaps by the interviewees, recognized as most important/urgent gaps. The interview questions in theme of gaps, formulated based on the gathered list of gaps from result of the document review chapter to verify and clarify the findings from documents, and also prioritize the gaps. As a result, the top 10 fields of gap under the top 5 categories identified and elaborated to be able to shortlist and link the relevant enablers and barriers to them. The enablers and barriers however, gathered from two different methods of ranking a list (the Table 2.1 from literature reviews) of enablers and barriers by interviewees, and analyzing result of open questions in the theme of enablers and barriers, through a qualitative data analysis method. At the end, the relevant enablers and barriers to deal with the important gaps selected from result of both methods and added together. The most relevant enablers and barriers to address each of the top 10 fields of gap, are listed and linked to that specific gap within the Table 4.4. The categories of enablers, barriers and gaps and relevant organizational levels to each enabler and barrier are also addressed in this table, which are required for solution making phase. This list of enablers and barriers, can be very reliable since it rooted in science and practice at the same time. The identified relevance's between enablers, barriers and gaps, will be used as base for further analysis and providing the final framework in the next chapter. Also, in the next sub-section, the recommendations mentioned by the interviewees to fill the existing gaps and link the tactical and operational level are mentioned, which will be used to formulate solution in the prospect phase as well.

Table 4.4. Most important gaps identified by practitioners and relevant enablers and barriers to deal with them

Exact gap	Enablers	Level	Barriers	Level
Category of culture, communication and behavior				
Communication and flow of information within and between the two levels	Spread knowledge and expertise to the other level & more communication	Tactical & operational	Complicatedness and required high number of transactions and interactions	Operational
		Tactical & operational		
Clear re-use target /strategy formulation & consistent follow up on targets	Creating roles with responsibilities on drafting , documenting and certify re-use works/steering the transition	Tactical	Lack of clear distinction among recycling and re-use activities	Tactical
	Defining ambitious targets & plans for re-use	Tactical	Existing priorities other than re-use: other sustainability targets & conflict of work procedures with other targets	Tactical & operational
	Complete implementation of existing sustainability target formulating framework (GWW)	Tactical	Lack of clearly formulated re-use targets and strategies	Tactical
	Obligation to re-use from internal client side& impose e-use responsible forces	Tactical		
Culture and mindset for re-use	Current sense of urgency for re-use in the young generation	Operational level	Risk aversion attitude and resistance to change from all internal and external parties	Tactical & operational
	Developing re-use mindset &creating sense of urgency for re-use by clarifying financial advantages and values of re-use for actors	Operational & tactical	Lack of re-use mindset	Tactical & operational
			Negative attitudes & cultural resistance towards re-used components and design methods like DFD , hesitates regarding the quality and durability	Operational
	Some people with circularity mindset/ sustainability teams and focusing further project's scope	Operational & tactical		
Category of contract , manuals & guidelines				
Compatibility of provided designs at operational level with re-use strategy at tactical level	Formulating specific design guidelines and principles like DFD in tactical level and implementing them at the operational level	Tactical & operational	Low integration and conduction of transition procedures from designers	Tactical and operational
	Adding LCA in design procedures and decision makings for re-use, and regulations for recalculating and extending components lifetime	Tactical	Existing material life span and need for materials with high EOL	Operational
	Emphasizing more on re-use in planning stages of projects	Operational		
Formulation of guidelines on re-use	Applying the Hand Book of Public Places as guide for operation and consistent re-vision of that	Tactical and operational	Lack of strict, consistent and explicit re-use guidelines	
	Existing manual of some material specifications for implementing re-use	Tactical		Tactical
	Existing attention from public clients to sustainability in the agreements & documents and forcing to implementing sustainability scan	Tactical	Guarantee & warrantee problems	Tactical & operational
			Lack of required technical documents for re-use (material inventories, and technical guidelines)	Tactical
	Putting circularity criteria in the tenders	Operational enabler	Lack of compatible collaborative procedures /method and approach	Operational

Procurement methods and contract models within re-use projects	Implementing innovative procurement models, public/private partnership & integrated project delivery methods like the RCC	Operational level	Single contract approach & Cost driven tenders (traditional)	Tactical
Category of knowledge experience and expertise				
Learning from pilots and previous/similar experiences	Positive previous experiences and lessons learnt from internal pilots and counterpart organizations	Operational and tactical level	Low number of successful pilot/project experiences	Operational
	Testing/implementing re-use within programs to enhance quality of the learning process	Operational and tactical level		
Category of organizational procedures and structures				
Fragmented tactical & operational active sections and groups and no explicit internal/ external re-use expert	Make the network of re-use more clear	Tactical	Lack of explicit and focused re-use specialists & required skills	Tactical & operational
	Existing expertise and potential to train/ Expert training for re-use	operational		
	Consulting; asking for support and intervention from external CE consultants, re-use experts and contractors with higher knowledge in re-use	Operational		
	Existing general "sustainability knowledge team" and internal advisors active on re-use	Tactical & operational		
Lack of specific work procedures/project stages for re-use	creation of more rooms and liberties within internal manuals, and decrease the bureaucracies	Tactical	Current internal restricting rules within manuals like Handbook of Public Places to work with reclaimed materials and complex iterative administrative works for projects	Tactical
	Formulating innovative work procedures compatible with re-use targets and circularity	Tactical	Use of linear and incoherent business models for re-use for long duration	Tactical
	Emphasizing more on re-use from initiation phase	operational	Extensive time of projects and lack of early stage time planning	Operational
Category of re-use support practices and requirements				
Linking the supply and demand/availability of materials	Providing regular (in-house) systems for transport, adjustment and storage with digital CDW management (machine learning etc.), providing data bases for reclaimable materials in the area and exploring opportunities	Operational and tactical	low number of demolition project with re-usable elements, incompatibility between functions and targets of reclaimed materials and new projects & low demand for circular projects	Operational
	Using & Collaborating with current inventories & data bases, existing salvage yards and innovative companies created for reclaimed materials and other public organizations	Tactical & operational	Lack of a consistent in house storage place/system (adjustment, transportation, storage) for reclaimed materials	Operational
			Required high quality materials, certain specifications and high technical standards for maintenance	Operational & tactical

4.9.1. Recommendations to fill the gaps and link the two levels

The last interview theme was recommendations given by the interviewees to fill the addressed gaps in practice, and link the tactical and operational level in implementing re-use strategy within the municipality. Interviewees asked to formulate recommendations in specific for the municipality and also in general to accelerate the re-use transition, in which also the municipality has a crucial role as a public client organization. Other than the direct recommendations addressed by practitioners, some lessons learnt from other public client organizations and from internal and external pilots or previous projects, have been suggested by practitioners. All gathered data analyzed with the qualitative data analysis method, using the Atlas.ti software, just like in other themes of interview. All recommendations are listed within the Table 4.5, combined by their relevant gaps, and the owners of quotations. The provided recommendations will be used in the next phase as one of the most important components in formulating the final framework.

Table 4.5. Expert Recommendations to fill the addressed gaps and connect the two levels

interviewee	Addressed gap	Recommendation
DHO1, DHO2, DHO4, DHTO1, DHTO2, DHTO3, DHT1,DHT4,DHT, DHO5,DHTO5,SC1	Clear re-use target formulation and consistent follow up	Formulating clear & accurate ambitions from initiation of project
DHO4,SC2	Communication and flow of information	dedicate more specific time on sharing information and communicating with contractors and suppliers
DHO1,DHT1,DHTO1,DHO3,DHT5,DHT4,	Compatibility of provided designs with re-use strategy	Development of exact design for re-usability targets
DHT3	Linking the supply and demand and availability of materials	Development of a material digital market place by the municipality
DHO1	Procurement method and contract models	Find potential organizations and market parties for collaboration
DHTO1,DHT4,DHT5	Learning from pilots	Follow-up the previous pilots
DHT5	Fragmented active sections and no explicit internal/external re-use expert	Formulation of a more focused leadership from top levels
DHO1,DHT3,DHTO4	Learning from pilots	Not to mix re-use pilots with complex projects
DHO1,DHT6	Lack of specific work procedures/project stages for re-use	Make it easier with little steps for colleagues
DHT6,DHTO2,DHT2	Culture and mindset for re-use	Providing sense of urgency
DHO1,DHT6,DHO2,DHTO3,DHT1,DHT4,DHO5,DHTO5,DHTO4	Communication and flow of information within and between levels	More evaluations/ follow ups on re-use between the two levels & More communications between the two levels
SC2,DHTO4,DHT2	Procurement and contract model	Outsource the reclaimed material to contractor/supplier and asking for a for high quality re-use
DHT5	Re-use target and follow-up/re-use culture and mindset	Focus on repairability and on site re-use as part of re-use strategy, and attract the asset management attention
DHT4,SC1	Fragmented active sections and no explicit re-use actors	Integrating more specialists and internal/external ambassadors explicitly for re-use
DHTO2,DHT1,DHT4	Mindset and culture	Increasing knowledge on re-use urgency within the organization
DHO2,DHO4,DHTO5	Communication and flow of information between levels	Participation of the tactical actors within some pilots/projects
DHT5,DHT2	Procurement and contract model	RCC should be tried again if there was compatible project scope

DHTO3,DHT5,SC2 ,DHTO4,DHTO5	Linking supply and demand and availability of materials	Focus on existing opportunities for re-use
DHTO2,DHT5	Clear target formulation and consistent follow-up	Make reporting and checking re-use requirements within projects mandatory
DHT1,DHT3	Learning from pilots	Plan more pilots with follow-up procedure
DHTO1	Procurement and contract model	Start the pilots with market consultation
DHTO1	Link the supply and demand and availability of materials	Share the reclaimed materials with other cities and put the responsibility of material with the context city of the new project
DHO2,DHO3,DHT O5	Fragmented sections and no explicate role for re-use	Translate sustainability into roles/Another IPM role for sustainability
SC2	Culture and mindset for re-use	Try to reuse specific materials before losing their aesthetic values, its quality and strength, instead of recycling
DHT2	Communication and Flow of information	Use of fully digitalized information system for circular assets :BIM
DHTO1,DHT2	Procurement and contract models	Use integrated & innovative methods and (useful parts of) RCC as explicit methods for circularity procurements
SC2	Linking the supply and demand and availability of materials	Search for re-usable materials in a context wider than the project's region
SC1	Linking the supply and demand and availability of materials	Wise planning with contractor to better match supply and demand side/plan to limit the transport
DHT5	Lack of specific work procedures/project stages for re-use	Cooperating with other public clients in providing specific work procedures
DHT4	Clear re-use target /strategy formulation & consistent follow-up on targets	Implementing monitoring system and rewarding based on the results
DHT5	Formulation of guidelines on re-use	Focusing on the synthesis between the *Handbook of Public Places* and asset management, in re-visioning for integrating re-use strategy and other innovations

4.9.2. Next steps

Within this chapter, 2 important results which will be the main components in formulating the final framework, have been gathered: 1. list of the top 10 fields of gap, and their relevant enablers and barriers 2. the list of recommendations provided by experts to fill the gaps. These results will be used as main inputs for the next chapter. To provide the final framework in the next phase, the recommendations will be added to the addressed organizational circularity implementation factors and sub-factors gathered from result of the literature review phase (Table 2.3). Finally, specific organizational procedures will be formulated for the municipality to follow in a format of framework, which are capable to overcome the barriers and implement the enablers to fill the gaps. Also procedures will be addressed with short-term/long-term targets based on availability of required resources for each specific procedure. After formulation of a preliminary framework the practicality of that will be questioned thorough conducting an expert evaluation procedure as well, to formulate the final framework.

Chapter 5:

Framework development & Expert evaluation

CHAPTER 5: FRAMEWORK DEVELOPMENT & EXPERT EVALUATION

In this chapter, the final framework is provided through following 3 stages of: providing a preliminary framework, testing it through an expert evaluation procedure and presenting the final framework. The preliminary framework is provided based on the results gathered from semi-structured interview phase and literature review phase. This chapter aims to answer the SRQ5 which is formulated as follows:

SRQ5: Which procedures should be followed to fill the gaps between tactical and operational level in implementing re-use projects?

To address the answer of this question three sections has been provided in this chapter. Firstly, a preliminary framework is provided in the section 5.1, with aim of filling the identified important gaps in previous phase. Secondly, the procedure of expert evaluation is explained in the section 5.2, followed by presenting the gathered results. The validated framework which is adopted based on expert's suggestions is presented as final framework in the section 5.3. Finally, the chapter conclusion is provided in the section 5.4.

5.1. The preliminary framework

In this section the way of developing the preliminary framework is elaborated. The mission of the preliminary framework is suggesting required procedures to the municipality to fill the identified gaps, implement more re-use projects, and accelerate the transition in long term. In this section, the main components of framework, and the instruction followed in development of that are explained briefly. The preliminary framework is presented at the end of this section, as well.

5.1.1. Framework's main components

4 main components used in the development of the preliminary framework. In the second part of the literature review, 9 frameworks focused on accelerating implementation of circularity strategies in practice have been investigated. As a result, common implementation 'factors' and 'sub-factors' between them have been collected, which are imply on 'circularity approach' in general, and 're-use strategy' respectively. These factors which are presented in the Table 2.3, are recognized as one main component of the formulated preliminary framework. The gathered implementation factors, should be used in framework to address identified gaps in practice between tactical and operational levels of the Municipality of Den Haag in implementation of the strategy of re-use. These gaps have been identified from comparison conducted between the operational and tactical level of the municipality, in the document review phase and validated & prioritized through a round of a semi-structured interviews. The important gaps which are presented in the Figure 4.4. considered as one other important component of the framework. The relevant enablers and barriers to the important gaps gathered from the result of the semi-structured interview chapter (Table 4.4.), addressed as the third component used in development of the preliminary framework. The final main component, is the group of recommendations formulated by the interviewees in the semi-structured interview sessions, which listed within the Table 4.5. Lastly, in this study, 8 categories have been identified as important areas, in which re-use strategy, enablers and barriers for implementing that and gaps in practice are investigated. The top 5 categories of gaps identified in the previous chapter are also involved in the preliminary framework, as areas in which implementation factors will be used for filing the gaps. The followed stages for developing the preliminary framework are elaborated in the next sub-section.

5.1.2. Development of the preliminary framework

To develop the preliminary frameworks all mentioned components have been included, namely; the important fields of gap, the relevant enablers and barriers to these gaps, the circularity implementation factors & sub-factors, and the recommendations provided by interviewees to fill the gaps. These components merged together in a specific structure and by following 4 steps which are mentioned below.

a. Addressing the gaps with circularity implementation factors

Each of the identified important gaps within the mentioned top 5 categories in the previous chapter, requires a specific intervention to be filled. In the provided framework, 10 fields of interventions have been formulated to fill the 10 important gaps and labeled by the relevant categories. Each gap addressed by its relevant circularity implementation factor, within a category, and define certain procedures to follow. The implementation factors are prioritized based on prioritization of gaps from Figure 4.4. and recognized as *re-use implementation factors* in the preliminary framework.

b. Formulation of procedures to overcome the barriers and fill the gaps

The most important part and aim of this framework is providing required procedures for municipality actors to implement and fill the gaps. As mentioned in the previous chapter, each field of gap is rooted in some barriers which required to be overcome or mitigate to fill that gap. Also, there are important enablers, useful in dealing with each field of gap. Enablers in each field are potential to overcome existing barriers in same field, but most of them are very general or cannot be implemented easily. Some accurate ***procedures*** are required to make the implementation of that enablers possible. Required procedures are formulated based on relevant recommendations provided by interviewees in the semi-structured interview phase (see table 4.5), and the circularity implementation sub-factors gathered from literature reviews (see table 2.3). The suggested synthesis between different framework components in filling the gaps, is indicated in the Figure 5.1.

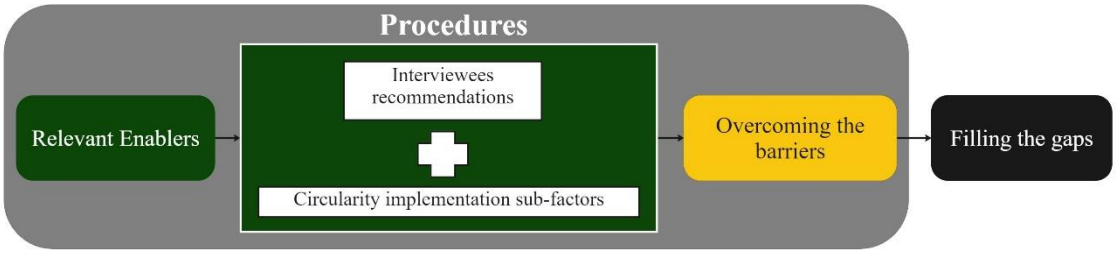

Figure 5.1: The synthesis between different framework components in filling the gaps

There are also few enablers that easily can be implemented, hence considered themselves as some procedures in the framework. The required procedures in preliminary framework formulated in a way that can fill the gaps completely, prevent any other barrier to be evolved in the future, and accelerate the re-use transition.

c. Considering short-term and long-term targets for procedures

Implementation of all suggested procedures require large amount of resources with different types, namely; new human resources, extra time and budget. Hence, each procedure identified by a short-term or long-term target in the framework, based on the quantity and availability of required resources for implementing that. The implementation of procedures with long-term targets, is more complicated and requires new resources to be integrated, and they can be recognized as second steps or further procedures in each field.

However, implementation of short-term procedures (first steps) is easier, and is anticipated to be possible with existing resources within the organization. Figure 5.2. indicates the specifications of short term &long term procedures. The procedures with short-term targets are also assigned to specific organizational levels which are explained in the next sub-section.

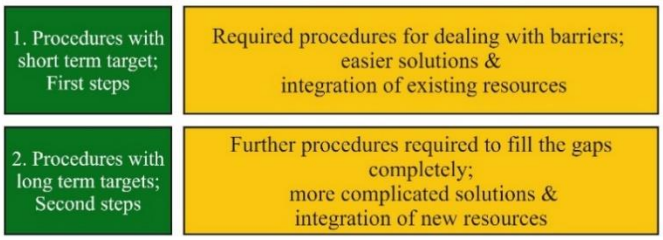

Figure 5.2: specifications of short term& long term procedures

d. Assigning relevant organizational levels to implement each procedure

The final stage in development of the preliminary framework is task division between different levels of tactical and operational for implementing the framework. In fact, to maximize the practicality of the framework for the municipality, the formulated procedures assigned to the actors in relevant organizational levels. Just like division of enablers and barriers in previous chapters, there is also a tactical & operational level which including actors active in the border line of the two levels, such as: internal clients, managers in IBDH department & actors involved in the Sustainability Knowledge Team. Also some procedures should be done in both levels. The division occurred based on information gathered from previous chapters like list of barriers and enablers, and also based on potentials in each level for implementing the procedures. In the next section, the preliminary framework which includes all mentioned components and formulated with mentioned instruction will be explained, and indicated schematically.

5.1.3. The preliminary framework

To overcome the existing barriers in implementation of re-use projects within the public client organization of Den Haag, and fill the identified important fields of gap, interventions are required. The preliminary framework which is formulated in this section contains 10 fields of interventions formulated to fill the 10 important gaps which labeled by the relevant categories. Each gap addressed by its relevant circularity implementation factor, within a **category**, and define certain procedures to follow. The factors are addressed as **re-use implementation factors** in this framework since they are used for implementing re-use strategy in this research. Suggested procedures also divided into two groups of **procedures with short-term** and **long-term targets** within the framework. The short-term procedures relevant to each factor, are also labeled with the potential organizational levels to implement them, namely: **tactical, operational or tactical & operational.** The procedures with long-term targets however, have not assigned to any specific level since they need further decision making stages in the future. The preliminary framework is illustrated in the Figure 5.3, indicating number of **procedures** required to be implemented by the municipality.

The identified gaps are existing in different categories. Hence, suggested procedures in this framework, are expected to be implemented in parallel and simultaneously by roles active in relevant areas to the addressed re-use implementation factors. However, the **re-use implementation factors** are **prioritized** for the municipality based on the prioritization of addressed gaps, realized from the semi-structure interviews, to make them able to deal with each gap based on its urgency. The procedures addressed in front of each implementation factor within this framework are explained in the next sub-sections.

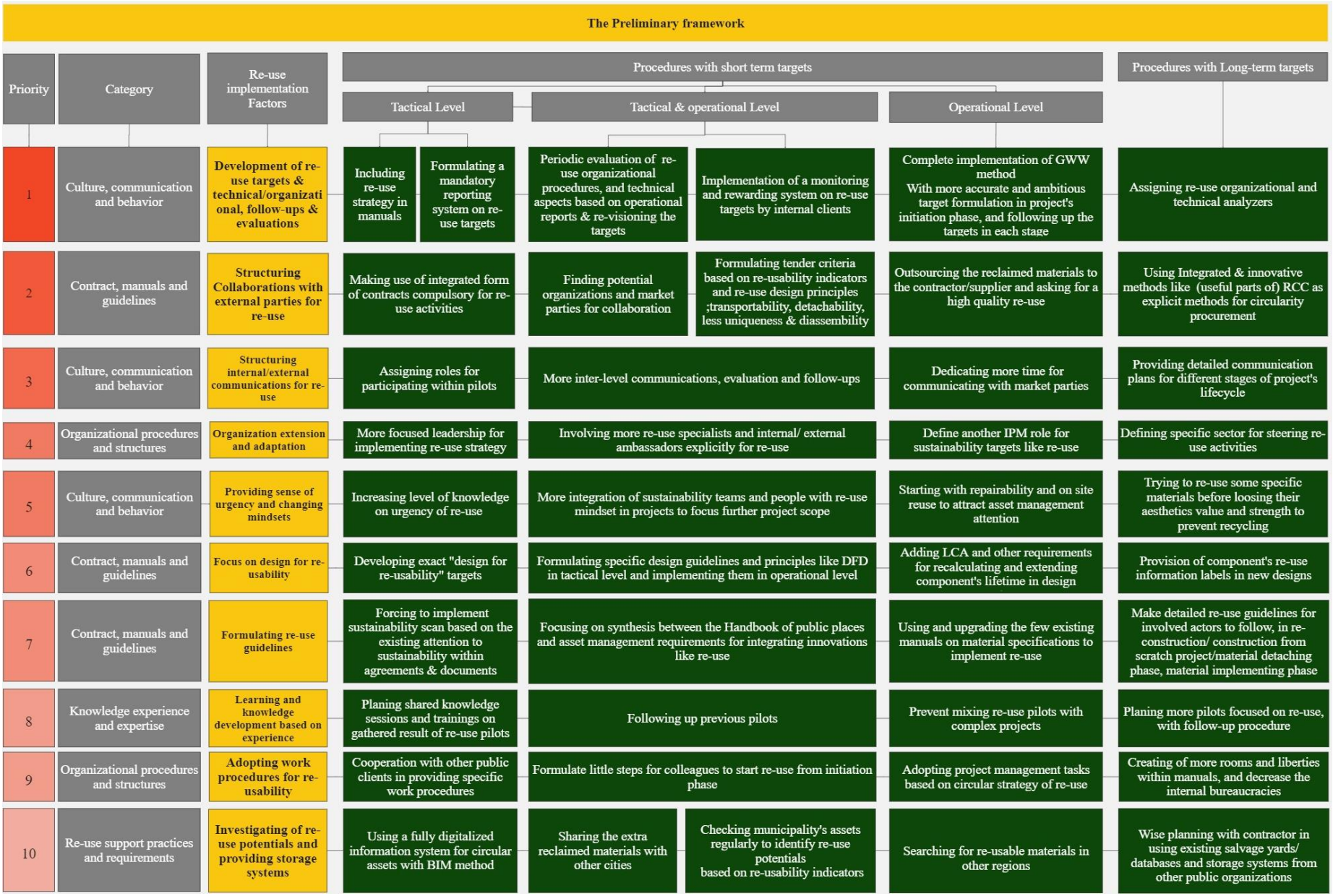

Figure 5.3. Illustration of the preliminary framework for accelerating the implementation of re-use infrastructures at public client organizations

1. *Development of re-use targets, technical/organizational follow-ups and evaluations*

The existing gap in 'clear re-use target/strategy formulation & consistent follow-up on targets' which is in the category of *Culture, communication and behavior* can be addressed by the factor of *Development of re-use targets, technical/organizational follow-ups and evaluations*. Relevant to this factor, 3 short-term procedures are recommended to be followed. To implement the enabler of, 'obligation to re-use from internal client & impose re-use responsible forces' it is recommended to *include re-use target & strategy in manuals*. Specifically, by integrating detailed re-use targets and strategies within the 'Manual of Public Places; the HOR', re-use projects can be easier implemented at the operational level, and public clients can refer to that in formulation of project requirements. Formulation and re-formulation of manuals, is under responsibilities of tactical level, hence this procedure targets the tactical level specifically. Since regular evaluations and re-visioning stages are required as well to correct possible scarcities within formulated targets and visions, a *mandatory reporting system on re-use targets & periodic evaluations & re-visions* should also be formulated by tactical level and implemented by operational level. Also *periodic evaluation of quality and quantity of organizational procedures and technical works* should be conducted by both levels through using existing circularity indicators. All elements should be evaluated and revised if required, such as: research activities, people performance, project execution & tactical support. Internal clients can also formulate a *monitoring and reward systems for re-use targets*. Within *operational level*, it is required to formulate *more accurate and ambitious sub-targets in project's initiation phase*, through early development of these targets in consultation with all involved actors. Re-use should not easily be formulated as 'as much as possible'. If any problem occurs, this target will be easily abandoned, hence more accurate plan is required. Operational actors should *implement the GWW ambition web completely*, by activating the target evaluation procedure of these webs. Actors should re-formulate the ambition web in each project phase, and compare that with initial web to check how far they were successful with realization of targets. Also it is recommended to the Municipality to *Assign re-use analyzers*, to implement enabler of *creating roles for certifying re-use works*. The analyzers should check the quality of all re-use activities. This procedure has long-term target, since these actors should have specific expertise and will be experienced external actor in the beginning. Integrating these experts will take some time and requires more budget.

2. *Structuring collaborations with external parties for re-use*

Making use of integrated form of contracts compulsory, by tactical actors is recommended to structure the external collaborations in re-use activities, and fill the gap in contract field. Also by involving the experienced market parties in re-use field from the design phase, the knowledge in the side of market parties can be shared in the operational level and finally the whole organization. *Finding potential organizations and market parties*, is recommended to operational and tactical actors for structuring collaborations. To conduct researches or projects with re-use strategy, these potential organizations should be approached and the municipality's network should be extended. It is recommended to operational actors to *formulate re-use specific award criteria* and *ask for re-use with higher quality* from market parties, within traditional form of contracts. The reclaimed materials can also be outsourced to the experienced market parties, since they can adjust the material, transport and storage them with higher quality. As a long term procedure, it is suggested to use innovative procurement methods with circularity focus like RCC. Implementation of such method requires conducting further investigations, pilots, and dedication of new resources.

3. *Structuring internal/external communications for re-use*

The implementation factor of *structuring internal/external communications for re-use* can address the gap in '*communication and flow of information within and between levels'*. Relevant to this gap, the only enabler is '*spread knowledge and expertise to other levels and more structured communication'*. In

implementing this enabler, it is crucial to know '*How'* the knowledge and expertise can be spread. Based on the gathered results from interviews, it is required that tactical actors know how the formulated manuals or targets are putting into practice and what are the defects of formulated targets. By involving the tactical actors in pilots, they will get better clue on how the re-use strategies are implemented in projects and how they can revise the targets to make them more practical. Also, by *more inter-level communications, evaluation and follow-ups* between two levels on re-use activities, the gathered knowledge in each level can be easily spread to the other level. As third procedure for implementing the mentioned enabler, *more time for communicating and sharing information with market parties* can be dedicated. This procedure should be done by operational actors who are in contact with market parties. The spread of knowledge cannot be complete and beneficial unless it also occurs inter-organizational. In most cases it occurs that the contractor only receives the requirements for re-use in the initiation phase without further checking of results with client in other stages. Hence, if a problem arises the contractor may easily skip the requirements. Also, in innovative field of re-use there are more knowledge in hands of market parties. Hence by more communications with market parties, specifically within projects, this knowledge can also be spread into project level and finally tactical level of the organization. *Providing detailed communication models for actors, during different stages of project's lifecycle* is also recommended. This procedure has long term target since designing specific models for communication and will take longer time. In each project stage, a coalition of specific actors should be formed for making project decisions with re-use considerations.

4. Organization extension and adaptation

Organization *extension and adaptation* is the first factor in *the organizational procedures and structures category*. Conducting a *More focused leadership on re-use strategy* from tactical level, is recommended under this factor. Without a focused leadership method at tactical level, required motivation for operational actors will not be developed. This procedure can also 'make the network of re-use more clear', which is an important enabler in this field. Also, another procedure which can implement this enabler is *integrating more explicit specialists and internal/external ambassadors for re-use*. This procedure should be followed by both levels. These ambassadors can be integrated from other public client organizations or market parties, experienced in re-use field. Using external ambassadors can be temporary and by following the parallel path of *knowledge development based on pilots,* in-house ambassadors can be trained. Moreover, *at operational level* a focused *role for re-use* can be added easily to the group of IPM roles and decrease the existing tensions among them for implementing sustainability targets. This procedure can also help the enabler of *'*making re-use network more clear*'.* Since it is not logical to add an IPM role for each target, defining one new IPM role generally for sustainability can be beneficial. A *specific sector for steering re-use activities* can be defined in long-term. After years, there will be lots of new roles, and new procedures, which need to be placed in a separate context. Defining one new sector for checking projects to be in line with re-use targets by a separate specialized team can suit the acceleration of this transition.

5. Providing sense of urgency and changing the mindsets

The third factor under the category of *culture, behavior and communication*, is bolding the importance of mindset and sense of urgency. The procedure of *increasing the knowledge on re-use urgency* can be followed by tactical actors to implement the enabler of 'creating sense of urgency'. By informing people from urgency of substituting raw materials with reclaimed ones in projects, due to restricted resources, the sense of urgency can be created within organization. Also informing them about positive monitory impacts of using second hand materials, people with resistance and mindset of using old methods can adopt themselves with the change. *More integration of sustainability teams and people with re-use mindset in projects to focus further than project scope* is the second recommended procedure. There are always people

with attitude and expertise in line with sustainability path, like people in sustainability knowledge team. Also, there are people with re-use mindset and re-use targets in life. Using these people in re-use transition can be beneficial, since they can spread re-use mindset around organization. These people, who should be found at both levels, can cooperate further than project time and budget scope, to integrate sustainability targets. Moreover, *operational actors* can start with repair-ability of reclaimed materials and on site re-use which has lower cost, and does not need transport and storage. This method can attract the attention of asset management department since the materials will be reclaimed from same site with same function and the quality of them can be assured. The last procedure under this factor is *Trying to re-use specific materials before losing their aesthetics value and strength* to prevent recycle, which needs further decision making stages among experts within the municipality and consequently has long-term target. The Procedures like this can activate the current sense of urgency in younger people, since there will be higher number of re-use projects in which they can be involved, and learn by doing.

6. Focus on design for re-usability

To fill the existing gap in field of *contract, manuals and guidelines*, one relevant factor is *focusing on design for re-usability*. Actors in tactical level are recommended to *formulate exact design for re-usability targets* in new directives for design teams. with these specific targets, the 're-use strategy can be more emphasized from initiation phases' which is one important enabler in filling the existing gap. Also, *specific design guidelines and principles like DFD can be formulated* by tactical actors and implemented by operational experts in design section, to fill the gap in design. Using design principles, the assets can be designed re-usable, detachable and re-use will be possible in future projects. Moreover, at operational level the experts can focus more on *life cycle analysis (LCA) and other requirements for extending component's life time* in design procedures. Higher lifetimes of materials can assure the durability, strength and consequently, re-usability of them. Lastly, *provision of component's re-use information labels in new designs* is recommended to the municipality, as a long-term procedure. Such labels can contain information like anticipated lifespan, suggested other functions, strength, dimensions, weight & year of production, to make checking the quality and quantity of re-usable materials, easier for experts at operational level.

7. Formulating re-use guidelines

The other factor to deal with the gap in *category of contract, manuals and guidelines* is *formulating re-use guidelines*. One recommended procedure relevant to this factor is *forcing to implement sustainability scan based on the existing attention from public clients to sustainability* within agreements. Tactical actors should push operational actors more, to implement the sustainability scan for all projects. The sustainability scan is pre-requisite for formulation of re-use sub-targets within projects. All actors should learn how to implement and follow-up this method. Moreover, one important concept in work procedure within municipality is the *synthesis between HOR handbook and asset management requirements*. Actors in operational& tactical level are recommended to more focus on this synthesis in parallel with '*re-visioning the work procedures to implement re-use'*. In operational level, people are suggested to *use the existing manuals on material specifications* to check whether each product is re-usable or not. These manuals are produced for restricted number of materials, like natural stones. It is also recommended to upgrade these manuals to make more concise blue-print for operational actors. Moreover, one long term procedure for the municipality is *making customized and clear guidelines for actors in each project stage* such as; re-construction, construction from scratch by re-use target, detaching re-usable materials and implementing reclaimed materials in new projects.

8. Learning & knowledge development based on projects

Currently, people needs more knowledge about real experiences like result of conducted pilots with re-use strategy which can be happened through *Planning shared knowledge sessions on re-use, trainings and workshops on gathered result of pilots*. This procedure should be followed by tactical level, based on gathered result of pilots. However, results of *previous pilots should also be followed-up* by experts first, which can activate *'learning from positive previous experiences enabler'*. Experts in border line of both levels, like tactical roles in the 'Engineering Firm' or actors in the 'Sustainability Knowledge Team' can formulate more consistent and elaborated advisory documents on result of pilots. Such documents should be sent to tactical actors to evaluate them and formulate re-use training documents and sessions. Operational actors should also be aware that *pilots on re-use cannot be mixed with complex projects*. The re-use targets are complex themselves, and need accurate reclamation audit procedures, and have extra stages of transport and storage. Such extensive steps can make danger for projects with complexities or risk. *Planning more pilots with follow-up procedure, focused on re-use* is also recommended, which needs dedicating more time and budget and even human resources like reclamation audit experts, etc.

9. Adopting work procedures for re-usability

Adopting work procedures for re-usability is another factor within *organizational procedures* category. C*ooperation with other public clients in providing re-use specific work procedures* is one beneficial procedure relevant to this factor, recommended to tactical actors. 'Formulating innovative work procedures compatible with re-use' is an enabler for filling the gap in field of work procedures, which can better be implemented in collaboration with other public clients. In innovative methods, limited knowledge is in hands of each public organization. Also they are fragmented pilots in different regions, governed by different public organizations. Currently some public clients already developed reports based on pilots, suggesting new work procedures for circularity targets. Tactical actors in different organizations can cooperate together to enhance quality level of such recommended procedures, test them in joint pilots or co-create new ones. Another procedure for both levels, *is formulating little steps for colleagues to start re-use from initiation phases.* With definite stages, people can know exactly what they should do and will try to do, but with general mandates like 're-use as much as possible' they can easily ignore the targets. It is crucial to *adopt* and customize *project management tasks based on circularity targets like re-use* as well. *Creating more rooms and freedoms within manuals and decrease the internal bureaucracies*, is also recommended with long-term target, since needs extensive time to be dedicated. There are lots of detailed requirements for using materials, within the most important manual for implementation of projects in the municipality (the HOR), which can restrict use of innovative methods like re-use. In some cases, existing bureaucracies do not allow to use opportunities for re-use in existing assets.

10. Investigating re-use potentials and providing storage system

Investigation of re-use potentials and providing storage system is address the gap in the category of *re-use support practices and requirements*. Relevant to this factor, actors in tactical level are recommended to *use fully digitalized information system for circular assets like BIM,* to record material specifications which are important for re-using them. Tactical actors can force the operational actors to integrate re-use principles within BIM system and share information of re-usable materials digitally. Also, another procedure is *testing suggested designs by municipality against re-usability indicators like transportability, or formulating them as reward criteria for market parties*, which should be followed by both levels. Also, actors in both level can make concession to *share the reclaimed materials with other cities but the responsibility of reclaimed materials should be put on the city of new project* to prevent further liabilities. In operational level, experts can *check the owned assets regularly to identify re-use potentials or search for them in other regions*. With

wise planning with contractor, municipality can easily use existing salvage yards or data bases as well. This planning is required to better match the supply and demand side and limit the transport time to make the project more sustainable. *Providing a regular (in-house) storage system with a digital CDW management,* is recommended to the municipality for long-term as well.

5.2. Expert Evaluation

The provided preliminary framework has been tested in expert evaluation sessions within the Municipality. The aim of conducting the expert evaluation stage was testing the correctness and practicality of the formulated framework. The set-up of the expert evaluation session, and result of that, are presented in the next sub-sections.

5.2.1. Set up of the expert evaluation session

The first step in the expert evaluation stage was selection of experts. Since the preliminary framework contained procedures required to be implemented in both tactical and operational levels, attendants should be selected from both levels, with an overview on the circularity topics like re-use. Moreover, since the identified important gaps and suggested procedures for filling them are more organizational, testing the practicality of them required wider view to the organizational procedures. Roles like team managers from teams with experience in sustainability and circularity fields & departments top managers, could be better informed from different organizational gaps and possible solutions for filling them. Managers are responsible for implementing organizational changes and check them if they function well. Hence, during the expert selection stage, it tried to approach team managers with sustainability experiences and top managers from involved departments in the research, like DSB, DSO & DBV. Since this phase of research was at the same time as summer vacancies, arranging the session based on availabilities of experts within all departments was very challenging. 4 experienced managers have been selected who were better informed by general topics of circularity and sustainability. Experts high level of information, their experience with management and topic of re-use made the gathered results from evaluations highly reliable. Table 5.1 representing the profile of the experts. The names of experts have been anonymized using the abbreviation of EX standing for Expert, and a number from 1 to 4.

Table 5.1. List of selected experts for expert evaluation session

Anonymized name	Expert's role	Years of experiences
EX1	Head of the Engineering Firm	35
EX2	Team manager	25
EX3	Team manager of Integral Project Management	35
EX4	Team Leader in Engineering Firm	30

Evaluation of a framework with different categories on innovative topic of re-use required presenting detailed explanations for experts, which was very time consuming for managers. Also, the time of research was very restricted. Moreover, implementations of all recommended procedures and filling all existing gaps are necessary to assure acceleration of re-use transition, and ignoring any filed of gap is not recommended. This is also the case with most of the existing circularity frameworks. Hence the evaluation stage has been conducted in 2 consecutive sessions of *Brain Storming* and *Main Evaluation*. In the *Brainstorming Session* the general concept, methodology of research, identified gaps and the preliminary framework presented for experts. Then they asked to provide feedbacks on the general structure and practicality of preliminary framework. The brainstorming session conducted online and for gathering the feedbacks, a Miro board has been shared with the attendants. All experts had consensus on the fact that the preliminary framework is a useful matrix in general for filling the identified gaps. However, they asked for focusing on the top 3 gaps

as more urgent fields to zoom in and intervene. Also, in consultation with experts it is concluded to run the main *Evaluation Session* one by one with each expert due to restricted availabilities of managers. The expert Evaluation Sessions ran in person and recommended procedures to fill the top 3 gaps, explained in detail for experts. The top 3 gaps are in fields of collaboration, communication and target formulation which are also more fundamental, and filling them can make the context to implement rest of procedures in the future. After explaining procedures for filling each gap, experts asked to tell if they are agreed that the procedures can fill the addressed gap, they are recommended to correct organizational levels and with correct short-term/ long-term targets. Also, they asked to explain their recommendations to improve each procedure and whole framework. The questions asked from experts are represented in the Appendix D.1 After the expert Evaluation Sessions, with the gathered results including expert's feedbacks and recommendations, the preliminary framework has been revised. The expert evaluation results and the final framework including the top 3 re-use implementation factors, are presented in the next sub-sections.

5.2.2. Expert evaluation results

The general results gathered from expert evaluation session, are presented in the Table 5.2. The experts asked to verify the procedures recommended to deal with the top three gaps in the framework. From all 4 experts, everyone was agreed that recommended procedures are potential to deal with the addressed gaps. In few cases, ideas of experts were neutral and they were hesitating that the recommended procedures are capable enough to deal with the addressed gap, or they were disagreeing with the procedure, the referred level or the suggested time to implement that procedures.

Table.5.2: Experts responses to the questions asked for validating the procedures within the preliminary framework

Priority	Category	Re-use implementation factor	Compatible re-use implementation factor factors	EX1	EX2	EX3	EX4
1	Culture, communication and behavior	Development of re-use targets and technical/organizational follow-ups and evaluations	Including re-use strategy in manuals	Agree	Agree	Agree	Agree
			Formulating a mandatory reporting system on re-use targets	Agree	Agree	Agree	Agree
			Periodic evaluation of re-use organizational procedures and technical aspects based on operational reports and re-visioning the targets	Agree	Agree	Agree	Agree
			Implementation of a monitoring and rewarding system on re-use targets by internal clients	Agree	Agree	Agree	Agree
			Complete implementation of the GWW method with more accurate and ambitious target formulation in project's initiation phase, and following up the targets in each stage	Agree	Agree	Agree	Agree
			Assigning re-use organizational and technical analyzer roles	Partially agree	Partially agree	Agree	Agree
2	Contract, manuals and guidelines	Structuring external collaborations for re-use	Making use of integrated form of contracts compulsory for re-use activities	Disagree	Agree	Disagree	Agree
			Finding potential organizations and market parties for collaboration	Agree	Agree	Agree	Agree
			Formulating tender criteria and re-use design principles, based on re-usability indicators; e.g. transportability & detachability	Agree	Agree	Agree	Agree
			Outsourcing the reclaimed materials to the contractor/ supplier and asking for a high quality re-use	Disagree	Disagree	Disagree	Disagree
			Using integrated and innovative methods like useful parts of RCC as explicit methods for circularity procurement	Partially Agree	Partially Agree	Agree	Agree

3	Culture, communication and behavior	Structuring internal/external communications for re-use	Assigning task of participating within pilots to some tactical actors	Agree	Agree	Agree	Agree
			More inter-level communications, evaluation and follow ups	Agree	Agree	Agree	Agree
			Dedicating more time for communicating with market parties	Agree	Agree	Agree	Agree
			Providing detailed communication plans for different stages of project's lifecycle	Partially agree	Partially agree	Agree	Agree

a. Applicability of suggested procedures for closing the identified gaps in practice,

Experts provided some recommendations to re-formulate the procedures and make them more applicable, which are elaborated per procedure in this sub-section. Some recommendations are also presented from experts in the next sub-section, to enhance the quality of framework in general.

- ***Including re-use strategy & targets in manuals***

All experts validated that existence of re-use strategy in manuals is required and implementation of that can be beneficial for dealing with the gap in *formulation of target/strategy, follow-up and evaluation on them*. However, according to the EX1, *for implementing this procedure operational level can also help actor's in strategic level bottom-up, to formulate more re-use specific strategies and targets.* The EX3 also mentioned that *the re-use strategy and targets should be clear, and have impact on all projects in the next years, and sub-targets within each project.* The sub-targets can also be quantitative and *measurable* in the projects.

- ***Periodic evaluation of re-use organizational procedures and technical aspects based on operational reports, and re-visioning the targets***

According to the EX1 *it is important to put the responsibility of monitoring and evaluating the implementation of re-use targets on specific departments. It could be the combination of procurement department and asset management.* Tactical parts of these departments can together conduct the task of monitoring and evaluating. The Expert 3 expected *existing of such cycle of evaluation and re-vision also between the tactical and strategic level, and found intervention of strategic level also important.*

- ***Complete implementation of the GWW method with more accurate and ambitious target formulation in project's initiation phase, and following-up the targets in each stage***

This procedure sounds very important by the experts, and check and follow up the exact implementation of method by managers at operational level is more important, according to EX1.

- ***Assigning re-use organizational and technical analyzers***

Involving the re-use analyzers have not recognized with long term target by experts. According to the Expert 2: *it is important that these analyzers also involved from formulation of organizational re-use targets, and not only for making the analysis on project results.* The EX2&3 mentioned that, *it is more practical if the analyzers start from counting the amount of materials that are used and re-used each year in projects, and making material inventories, which also help to easier re-formulate the re-use targets.*

According to the EX3 *it is depending also on the lifecycle of materials, since different materials needs different ways of monitoring, and analyzers should set different ways to measure things.*

- ***Making use of integrated form of contracts compulsory for re-use activities***

Experts found integrated form of contracts required to challenge the market to come up with innovative solutions. However according to the EX1, *the possibility of using such contracts should be checked. There are very few opportunities for doing projects in The Hague with such contracts.* Since projects are related to each other in the city, it is difficult to hand out lots of responsibilities to market parties with integrated form of contracts. Also according to the EX2: *the development in the city requires constant changes and integrated contracts make it difficult because each change makes changes in contracts and needs new negotiations*. According to the EX2 &EX3: *the knowledge and experience of using integrated form of contracts in large scale is not there yet for the Municipality, hence it should be on long-term to gain more experiences.* Hence, in implementing this procedure, the sort of project and potentials of that should be considered. According to EX3*: it can reformulate to 'using traditional form with more specific attention to re-use and also using integrated form of contracts'.*

- ***Outsourcing the reclaimed materials to the contractor and asking for a high quality re-use***

Experts were all disagreed on this procedure, and they believed that the ownership of the re-usable materials should be with the Municipality. According to the EX3: *by outsourcing the materials to different contractors, it will be complicated in construction of new assets within the city. The quality and specifications of materials should be safeguarded at same level in all new projects, which can only be assured by keeping the ownership.* Instead experts asked for another procedure to keep the ownership and facilitate the re-use at the same time. The experts were all agreed on 'providing an in house storage system or a digital market place', which was one of the procedures addressed for the gap in *re-use support* in the preliminary framework. According to the EX2: *providing a place is hard since quality control, logistics and guidance are required, but we need to invest on it in long-term for re-use*. The relevance of this procedure to structuring external collaborations justified by the EX1& EX3 as: *it will be helpful if we have our own system and we should look at cities with storage system like Amsterdam and see how they do it*. Also, *provision of a digital market* place found by the Ex1 as best part of this procedure, since the municipality can share its reclaimed materials with other parties, and it is doable in short-term. According to EX2: *by keeping the ownership the municipality have the incentive to provide the best quality and it is more profitable economically, but outsourcing give the market party this incentive*.

- ***More inter-level communications, evaluations and follow-ups***

Experts were agreed that; communications, follow-ups and evaluations between projects and tactical level is necessary and should have short-term target. However, according to EX2, *the solution is not conducting 'more' communications.* According to experts; it is required to facilitate that people on different levels meet at certain moments and share ideas. Having *the re-use network clear* using the existing communication channels is suggested by experts, which should be facilitated by managers. Mangers should stimulate people to be proactive in communicating with active actors on the re-use topic. It is recommended by experts to re-formulate this procedure to' *facilitating communication on re-use between levels by managers'*.

- ***Dedicating more time for communicating with market parties***

According to EX1: *it is more about structuring the information gathered from communicating with market parties*. According to the EX3& EX4, *these communications should also be started from tactical level and*

even strategic level, and they should be involved from the phase before initiation of project to use their knowledge and experiences.

- ***Providing detailed communication plans for different stages of project's lifecycle***

According to EX2: *detailed written down plan for communication can make in-flexibility*. It found by experts that constant interactions, and structure for communications is required, but not in detailed format.

b. Experts general recommendations to enhance the quality level of the final framework

According to EX1 the framework is a good tool which help to make further decision making stages in the organization. The experts recommended to change the structure of the framework for the top 3 implementation factors. *The experts found some procedures interrelated and recommended to make a circular link between those procedures.* It is also recommended by the EX2, in case of linking the procedures; relevant to the factor of structuring external collaborations, *finding potential organizations* and *formulating tender criteria* should be prior than *using integrated form of contracts*. According to EX4: *the link between procedures can ensure the practicality of them, for instance: formulating reporting system is practical if it comes before the evaluation procedure.* The new procedure*; 'Making the active network on re-use more clear'* is suggested by EX1 & 2 to the tactical level, as first step to facilitate the communications. This procedure should be added into the framework, since it was also recognized among enablers relevant to the gap in the *fragmentation between tactical and operational level*. Lastly, it found required by experts to indicate the relevance of some procedures with strategic level as well.

5.3. The final framework based on the validated results

Based on the gathered comments during the evaluation sessions, the tested part of framework (for top 3 gaps), is practical and can be implemented in the municipality with some minor changes in the procedures. Also, based on the received comments, some changes in the structure of the framework can help actors in the municipality to put the procedures into practice easier. An analysis on the gathered results and the final framework formulated based on that are presented in this section.

5.3.1. Analysis of the results

In general experts were agreed that the identified top3 gaps are the most fundamentals and require urgent interventions, hence final framework should be only focused on filling them. The category of interventions and the re-use implementation factors also verified by all experts. Also, there were not many comments on the suggested short-term/long-term targets for procedures. The level which considered responsible to implement each specific procedure, also recognized compatible for implementing that procedure. Most of the expert's comments were on the way the *procedures* have been formulated and the way they presented in the framework. Some procedures re-formulated based on comments to be more practical for the municipality. Experts had consensus that procedures which formulated very strict may trigger the existing flexibilities in the organization, which is not desired. Moreover, since most of the procedures can follow each other and create loops between different levels, they can be linked together. The recommended procedures re-formulated considering the experts' unified comments, and a new structure proposed for framework which indicates links between procedures. Lastly, based on expert's opinion, since the target formulation should start from strategic level, this level also integrated in the framework.

5.3.2. Formulation of the suggested final framework

In this sub-section, changes in procedures based on experts' comments and recommended links between them are explained under each relevant implementation factor, followed by the indication of the final framework.

a. Culture/communication and behavior: Development of the re-use targets and technical/organizational follow ups

Between the recommended procedures for filling the gap in target formulation and follow-up, a logical sequence and link recognized by all experts. To make *re-use target formulation and follow up factor* more practical this sequence should be more clear. The first procedure can be *including clear organizational re-use targets and strategies within manuals.* These re-use targets and strategies should be formulated concisely at the strategic level with bottom-up help from operational actors, and then formulated into manuals by tactical level. The targets should be very clear and impactful for using in all projects commissioned by the municipality. The bottom-up help from the operational level can be implemented by involving *the re-use organizational and technical analyzers*. Hence the analyzers should be involved not only within the operational tasks and for analyzing the results but also at the strategic level. Analyzers can find out the number of used and re-used materials in projects (material inventory) within a specific period of time and from that can estimate the realistic re-use targets and help the strategic level in defining the targets and re-uses strategies. The tactical actors can integrate these targets and strategies within manuals like the 'Handbook of Public Places', and also *formulate a reporting system on re-use targets* based on them. This reporting system should be connected to the GWW ambition web's follow-up procedures as well. Operational level can define specific sub-targets within each project in the initial ambition web and should re-formulate the web in each stage to check the realization of targets and provide reports for analyzers. Analyzers then can analyze the reports, organizationally and technically and forward the results to the *managers in the border line and internal clients to monitor and reward*. Then the result of analysis should go to the relevant tactical departments (asset management & procurement, etc.) for periodic evaluations. Finally, there will be another cycle of evaluation on targets between tactical and strategic level to see if there is a need for re-visioning the targets. By following these procedures, ambitious sub-targets can be formulated in projects at third level of the GWW webs, and even full re-use can be facilitated in the long-term.

b. Contract, manuals and guidelines/Structuring collaborations with external parties for re-use

Subtle changes also implemented in the recommended procedures under this factor based on expert's opinions. Tactical actors should focus on *finding experienced market parties* for collaboration on re-use projects or using their knowledge and experiences in re-use field. Then, in collaboration with operational actors, *tender criteria and re-use design principles* should be formulated *considering re-usability indicators* such as *transportability and detachability of materials*. Regarding the form of contracts, the *traditional model should be use by more focus on re-use method* at operational level, involving the formulated tender criteria. In long term, after gaining required experiences and knowledge, *integrated form of contracts* and *innovative models like RCC should be implemented, as circularity specific procurement methods*. *Operational level should also provide a digital market place for reclaimed materials* and collaborate with other municipalities or contractors for each project through that. In long term, *a regular (in-house) storage system* should be provided and linked to the created digital market place.

c. Culture, communication and behavior: Structuring the internal/external communications for re-use

Structuring the internal/external communications also verified by experts as a beneficial factor for implementing re-use strategy in projects. Some procedures formulated relevant to this factor, changed a bit based on suggestions of experts. It recognized by the experts that implementing the procedure of *defining some informed tactical actors to participate within pilots* is definitely useful for checking the practicality of formulated re-use targets within manuals. It suggested by experts that before structuring the communications, the *network of active actors on re-use topic in the organization* should be cleared by tactical actors. Then, managers in both tactical and operational levels should *facilitate the inter-level communications and flow of information from operational level to tactical* and other way around; like in transferring the result of pilots. At operational level, *more communication stages with market parties* should also be formulated, starting from before project's initiation phase. Also in long-term, *communication plans* can be provided for each stage of project's lifecycle, to be followed by relevant actors. By clear communications at project level, the information can be transferred intact and more easy to the operational actors outside the project scope and consequently to the tactical level.

The final framework is illustrated in the Figure 5.4. The links between procedures are indicated in the final format, to make it more user friendly. Also, to provide this link between the three implementation factors, they prioritized again at the end and a sequence created between 3 fields based on expert's opinions which is indicated by black dash-arrows in the figure. After *developing the targets and evaluations*, to facilitate follow-ups between levels, the *internal/external communications* should first be structured, and then the *external collaborations* can be enabled. The links between procedures relevant to each implementation factor are indicated in the framework with black solid-arrows. In addressing the gap in *target formulation* it is recognized by all experts that intervention of strategic level with help of operational actors is also required. Hence, the *strategic level* is also added to the final model. However, strategic level was not in the scope of this research, hence intervention of this level is indicated by different color and dash-line (Red dash-arrows). The bilateral arrows between strategic level, each implementation factor and procedures linked to them, indicate the consistent relation which should exist between the result of implementing procedures and strategic re-visioning stages. The type of arrows is also illustrated in the Figure's legend.

- ***Practical Implementation***

The recommended procedures in the formulated framework are interrelated, which means result of implementing number of procedures should be followed by work of actors in the same or another level. This framework is multi-level and should be put into practice by all actors in all 3 levels of tactical, operational and strategic, and also actors in the borderline of tactical & operational levels. To implement the framework, managers in each organizational level can formulate specific advisory documents and re-formulate the suggested procedures for each level into detailed tasks for the relevant actors. In most cases, implementation of short-term and long-term targets are interrelated as well, and experience with implementing the short-term target can reveal the necessity of following the procedures which should be developed in long-term. Moreover, for implementing procedures with long-term target dedication of more resources are required. Managers in tactical and strategic level can analyze the result at the end of implementing the short-term targets and see if developing the long-term targets and provision of new resources for them are still required. By implementing the presented framework, there will be more structured activities at the operational level and the organizational context will be ready to conduct more re-use projects.

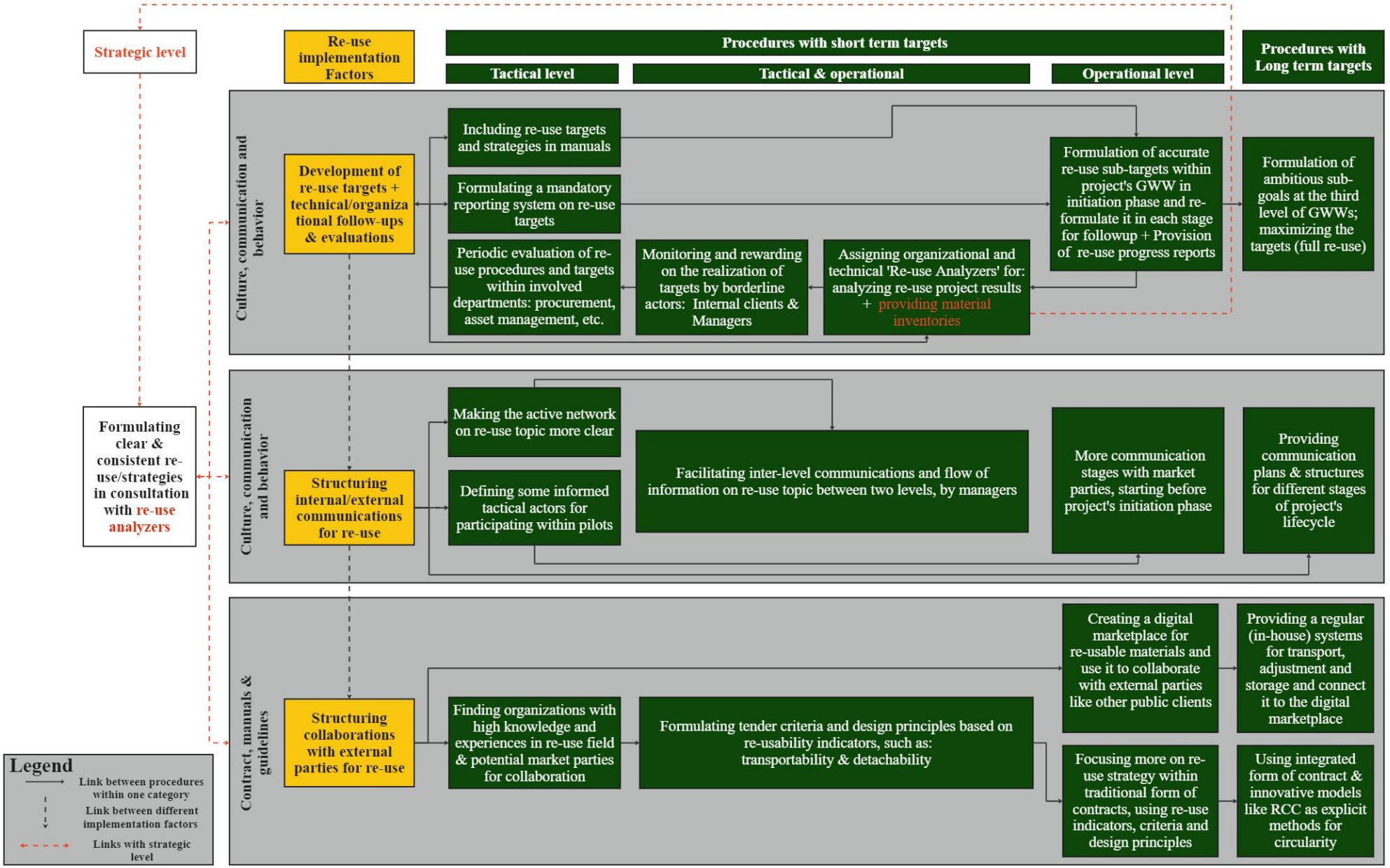

Figure 5.4. The Final framework

5.4. Chapter conclusion

This chapter was aimed for formulating the procedures which should be followed to fill the identified gaps between the tactical and operational level of the public client organizations in implementing re-sue projects. To fulfil aim of this chapter, each of the identified important gaps in the semi-structured interview phase, recognized as one field which requires intervention. The interventions provided as specific procedures required to be followed for filling the gaps. The required procedures formulated and presented in format of a framework in this chapter. Each field of gap in this framework addressed by a relevant re-use implementation factor, gathered from the result of literature reviews. In total, 10 factors have been formulated to address the 10 identified important gaps. The implementation factors are prioritized based on prioritization of gaps. Each implementation factor indicates required general intervention, and mentioned within the category of the addressed gap, and defines specific procedures to follow. The formulated procedures were the most important part of the presented framework.

As mentioned in the previous chapter, relevant to each field of gap there are barriers which required to be overcome to fill the gap. Also, there are important enablers, useful in dealing with each gap. Enablers in each field are potential to deal with the existing barriers in same field, but most of them are very general or cannot be implemented easily. Concrete ***procedures*** are required to make the implementation of that enablers possible. Required procedures are formulated based on relevant recommendations provided by interviewees in semi-structured interview phase, and the circularity implementation sub-factors (focused on implementing re-use strategy) gathered from literature reviews. To maximize the practicality of the framework for municipality, the formulated procedures assigned to the actors in relevant organizational levels of tactical, operational and tactical & operational, just like division of enablers and barriers in previous chapters. Also, based on availability of required resources for implementing each procedure, short-term or long-term targets put on each procedure. The framework provided in a preliminary format addressing all 10 fields of gaps, and through evaluating by experts focused on addressing only the top 3 and urgent gaps in the municipality. The final framework recognized three re-use implementation factors of: *development of re-use targets, technical/organizational follow-ups & evaluations, structuring internal/external communications for re-use, and structuring collaborations with market parties,* as most fundamental factors to address the gaps between tactical & operational level in implementation of re-use. In the formulated framework, links between the procedures relevant to each factor also identified since the result of procedures done by different levels are interrelated.

To make *re-use target formulation and follow-ups* more practical, it should be more clear in the organization. Through following procedures formulated relevant to this factor a cycle of: *target formulation by tactical level, implementation of them at operational level using the GWW webs, analysis of progress by analyzers, monitoring by borderline actors, and periodic evaluations by tactical departments* should be formulated. By following this cycle, ambitious sub-targets can be formulated in projects at third level of GWW webs and even full re-use can be facilitated in long-term. The strategic level is not in the scope of this research, however, integration of this level in the framework was required to complete the cycle of target formulation and follow-ups. The target formulation should be started from this level and the result of analysis of targets, should be transferred to this level again to make re-visions on targets in required cases. *Structuring the internal/external communications* is the second factor for implementing re-use. First the *network of active actors on re-use topic in organization should be cleared* by tactical actors, and *some informed tactical actors should be defined to participate within pilots* for checking the practicality of formulated re-use targets. Then, managers in both tactical and operational level should *facilitate the inter-level communications and flow of information between the two levels*. At operational level, *more*

communication stages with market parties should also be formulated, starting from before project's initiation phase. Also in long-term, *communication plans* can be provided for each stage of project's lifecycle. By clear communications at project level, the information can be transferred intact and more easy to operational actors outside of project scope and consequently to the tactical level.

To implement the factor of *structuring the collaborations*, tactical actors should focus on *finding experienced market parties* for collaboration on re-use projects or using their knowledge and experiences. Then, in collaboration with operational actors, *tender criteria and design principles* should be formulated *considering re-usability indicators*. Regarding the form of contracts, the *traditional model should be used by more focus on re-use method* at operational level, involving the formulated tender criteria. After gaining required experiences, *integrated form of contracts* and *innovative models like RCC should be implemented*. *Operational level should also provide a digital market place for reclaimed materials* and collaborate with external parties through that. In long term, *a regular (in-house) storage system can also be provided by municipality.*

There is also a link between the three re-use implementation factors in the suggested framework. After *developing the targets and evaluations*, to facilitate follow-ups between levels, the *internal/external communications* should first be structured, and then the *external collaborations* can be enabled. To implement the framework managers in each organizational level should formulate separate advisory documents and re-formulate the suggested procedures for each level into detailed tasks for the relevant actors. Following procedures in the formulated framework can fill the identified gaps and provide the required link between the tactical and operational level, to implement more re-use projects in the future. In the next chapter, a discussion on the gathered results will be conducted and also some limitations of this research will be explained.

Chapter 6:

Discussion & Research Limitations

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CHAPTER 6: DISCUSSION & LIMITATIONS

In this chapter, a discussion on the findings of this research is provided in the section 6.1. Also, some limitations have been found on the provided research which are addressed within the section 6.2 of this chapter.

6.1. Discussion on the gathered results

Accelerating implementation of circular infrastructure projects with reuse strategy to reduce the raw material consumption and emissions, is currently an urgent topic in the global and Dutch context, which needs following specific organizational procedures (Boweconomie, 2022; Government of the Netherlands, 2018; Oppen, Croon, & De Vroe, 2018). Infrastructures are owned and commissioned by the public client organizations (PCOs) (Geerts, Ghyoot, & Naval, 2020), hence PCOs have determining role in conducting and accelerating the re-use transition in this sector (Loorbach, 2010). Complex and unique organizational characteristics of re-use projects created barriers for development of them in the infrastructure sector (Oppen, Croon, & De Vroe, 2018). As result of these barriers some gaps are created between the tactical and operational level of the PCOs in implementing re-use strategy, which hindered acceleration of re-use transition within these organizations and in the infrastructure sector. The main objective in this research is providing specific organziational procedures for public client organziations to follow, to accelerate the re-use tranistion at operational level of these organziations. This target reached through formulating the required procedures in a format of a framework for public client organizations, to fill the gaps between tactical and operational level of these organizations, in implementation of re-use strategy. Currently, there is less attention to the acceleration of re-use transition in the infrastructure sector and role of public clients in that, in the existing studies, hence, this research provides valuable findings for practice and scientific works in field of re-use transition in this sector. This research is conducted with qualitative method, in 3 main phases including; theoretical, emprical and solution development phase, which aimed to answer 5 sub-research questions.

From academic point of view, this research study added into the theoretical body of knowledge, in the field of re-use transition in the infrastructure sector. There are various researches conducted on the urgency and values of implimenting circualrity strategy of re-use in the infrastructure sector, however, there is less attention to implementation of high number of these projects in practice (Boweconomie, 2022; Valavanidis, 2018). Few studies conducted on the implimentation of re-use strategy, are only provided on restricted number of cases and have not provided generalized information for accelerating implimentation of these projects (Boweconomie, 2022; Rijkswaterstaat, 2021; Rijkswaterstaat, 2023). In the knowledge of author, existing researches with focus on acceleration phase of re-use transition in the construction industry are only conducted in the built environment, and this research is addressing acceleration of re-use strategy in the infrastructure sector for the first time. Using enablers to overcome the recognized barriers in the implementation of prototype & pilot projects (Superti, Houmani, & Binder, 2021), can help to move the transition forward to the acceleration phase (Hekkert et al., 2011). Many researches have investigated the situation with the transition towards different CE strategies in construction industry, through identification of enablers and barriers and categorizing them (Ababio & Lu, 2022; Ekins, et al., 2019; Knoth , Fufa , & Seilskjaer , 2022; Nadja Yang et al., 2021; Rios , Grau , & Bilec, 2021). However, according to previous studies, re-use is more efficient and effective strategy in safeguarding the materials and resources than other circularity strategies (Anastasiades et al., 2020; Ekins, et al., 2019; Vermeulen, Witjes, & Reike, 2019). Few studies which investigated the enablers and barriers for implementation of the re-use stagey, were

conducted in the whole construction industry and not in the infrastructure sector in specific (Knoth , Fufa , & Seilskjaer , 2022). In this study the enablers and barriers for implementing re-use strategy in the infrastructure sector are collected in specific, and through both theories and empirical studies which is one of the significances of this research. Moreover, it found out for overcoming the barriers, implementing the enablers and accelerating circularity transitions, a systematic change (Ababio & Lu, 2022) is required, which only can be implemented through following specific frameworks in the organizations (Circle Economy, 2021). Various circularity frameworks have been provided until now in different sectors, focusing on implementing and accelerating the implementation of circularity approach in general (Mendoza et al., 2017). Few frameworks have been concentrated on re-use strategy which were not in the infrastructure sector. The provided circularity framework in this research presented specific circularity implementation factors fit for implementation of the re-use strategy in the infrastructure projects. The addressed implementation factors in this research also can be used as data in further studies with topics like evaluating the quality of re-use projects. Other significance of addressed implementation factors in this research is that they are relevant to the context of public client organizations, which have crucial role in accelerating the re-use transition in the infrastructure sector as commissioners of the infrastructure projects (Geerts, Ghyoot, & Naval, 2020). Formulated implementation factors in literatures focused on the role of public organizations in implementing re-use strategy (Klein, Deutz, & Ramos, 2021), are not specifically defined for construction industry.

Moreover, conducting higher number of re-use projects or accelerating re-use transition at operational level of the public client organizations require a good connection and synthesis among tactical and operational level (Loorbach, 2010). Conducted researches on the circularity topic in the construction industry, within the context of the public client organizations, only pointed the strategic level, or investigated the operational level only in the built environment (Geerts, Ghyoot, & Naval, 2020; RVB, 2022). Investigating the connection between tactical and operational level of PCOs, and improving that to implement more re-use projects in the infrastructure sector was the focus area in this research, which made it highly valued and distinctive from other researches in circularity and re-use field. All findings in this research, including the identified gaps in practice, enablers and barriers for implementing re-use projects, put in the context of specific categories of investigating circularity strategies. This categorization highlights the fields that require intervention in implementing re-use projects, and presented in the final framework as well. Another unique approach in this study was dividing the problem and solution in different levels of tactical, operational and tactical & operational. The presented procedures in the formulated framewrok, are provided specifically for each of the tactical and operational levels, and in some cases both levels. In the literatures, only there are few framewors with concentration on different levels, which are mostly not investigating the tactical level.

This research conducted in a qualitative data analysis method, which was the best option to prioritize and shortlist (Bozonelos , 2020) the gathered data such as; the main enablers and barriers, and linking them to the relevant gaps. Using the qualitative method the validity of gathered data can be tested through various methods like “triangulations” (Lacey & Luff, 2007), which was the case in gathering the most important gaps, enablers and barriers in this research. Collecting the data from multiple resources (Lacey & Luff, 2007) like document reviews, interviews and literatures made the result of this research more reliable.

From practical point of view, this research suggested specific organizational procedures to the public client organizations, which provided easier path to follow for accelerating implementation of infrastructures with re-use strategy. Within existing studies conducted on re-use topic in other public client organizations, mostly the technical gaps and the barriers are addressed, such as structural and safety problems with

reclaimed materials in projects (Rijkswaterstaat, 2021; Rijkswaterstaat, 2023). Also, existing frameworks which used in practice for accelerating implementation of circularity strategies like re-use in infrastructure projects, are mostly focused on technical procedures like integrating re-usability principles, circularity indicators and tools (Coenen, 2019; Tobben & Opdennaker , 2022). These principles and indicators cannot fill the fundamental gaps in communications, collaborations and target formulation. However, most findings in this research such as important gaps in practice, triggered the organizational aspects, where more interventions are required (Oppen, Croon, & De Vroe, 2018). The most urgent gaps identified in this study are purely organizational. Gap in target formulation, follow-up & evaluation/ communications and collaborations with market parties in implementing re-use projects, identified as top 3 gaps in this study. Finding and filling the organizational gaps in this research, can prepare the context to work with the identified technical indicators mentioned in other studies as well.

Also, as mentioned in the reviewed documents in this study, the *Sustainable Commissioning Program* is conducting by the *Sustainability Knowledge Team* of the municipality, for implementing projects with sustainability and circularity targets. This program provides the main framework for following circularity targets in the municipality organization, focused on operational procedures. All suggested procedures in this program, are formulated to be done at operational level and specifically within project's lifecycle. There is no connection with tactical level in this program. However, the presented framework in this research is implied on linking the tactical and operational level of the public client organizations in field of implementing re-use strategy to provide the context to conduct more re-use projects at operational level. Linked organizational levels and higher number of projects with re-use focus, will contribute to acceleration of the re-use transition in long-term. The presented circualrity implimentation factros of *target formulation, strcuturing communications & collaborations* in the presented framewrok, are mentioned also in few existing framewroks with focus on enhancing the quality of organizational procedures to accelerate transition towards implementation of circular infrastructures (Kanters, 2022). However, these implimentation factors are not addressed detailed and clearly, and not presenting specfic procedures to follow with different organziational levels.

One significance of the presented framewrok in this study is the detailed and interrelated procedures which fomulated for each specific level of organization (strategic,tactical & operational). For instance, there are consequtive detailed procedures for *formulating the taregt and following-up them* between levels in the provided framework. The division of procedures between levels and also indication of clear links between them, made the suggested framework more user friendly for the public organizations. Moreover, the suggested organizational procedures in the presented framework for dealing with the identified gaps, are not only based on the reviewed academic resources (the implementation factors from literature), but also experiences in practice (suggestions provided by practitioners) which are not addressed within the existing studies. Other than the framework, some recommendations are formulated as result of this research for other public client organizations to enhance the quality level of their collaborations in the infra5daagse network. Implementing this framework and recommendations into practice will contribute to increase the number of circular projects in the future in Den Haag, and Netherlands and accelerate the re-use transition in the infrastructure sector.

6.2. Research Limitations

The limitations of this research are listed as follows:

- The idea of implementation of circular strategy of re-use in the infrastructure projects came up in line with the national program of renovating the infrastructures within the Netherlands. This program has national targets and different public-private networks such as 'Infra5daagse' are involved in that. In this research, there was only the opportunity to investigate the implementation of re-use strategy within the context of one public client organization; the Municipality of Den Haag. To accelerate the re-use transition in the infrastructure sector, and make the targets within this national program more achievable, investigation of procedures *between* the public client organizations in implementing re-use strategy is also required. Connecting these organizations and approaching the program's targets in the national context is a more complicated challenge and requires to be explored in a separate study.

- Although investigation of organizational procedures within the public client organizations was focused in this research, some contractor and supplier parties also required to be interviewed, to use their knowledge in formulating the final solution. In this research, only two market parties interviewed, and this can be addressed as another limitation. By interviewing more contractors and suppliers, better clue from current market situation could be provided, which was necessary to investigate gaps, enablers and barriers in fields like; external collaborations and link between supply & demand. Gathering ideas from higher number of market parties can be beneficial in further investigation of this topic.

- Due to restricted availabilities of the managers in the organization, and their request for only zooming into the top 3 of identified gaps, only procedures for filling the top 3 gaps have been evaluated, and presented in the final framework. However, to connect the tactical and operational level completely in implementing re-use projects, other recommended procedures should also be implemented, to fill all the existing gaps.

- The expert evaluation session has only been conducted as an internal session within the Municipality of Den Haag. To be able to formulate a general solution for all public clients for implementing more re-use projects, an external evaluation session is also required. Some representatives from other public client organizations should also evaluate the gathered results.

- The identified gaps, only gathered based on conducting a comparison between tactical and operational level of one public client organization. To be able to prescribe the provided solution to all public client organization, investigating the current situation with implementing re-use projects in other public client organization is also required.

  Despite these limitations, this research provides valuable insights in field of implementing circularity strategy of re-use in the infrastructure projects and accelerating the re-use transition by public client organizations. A list of enablers and barriers, re-use implementation factors, and provided procedures in the final framework are most important contributions of this study to the academia and practice.

Chapter 7:
Conclusion & Recommendations

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CHAPTER 7: CONCLUSION & RECOMMENDATIONS

The aim of this research was providing a framework which link the tactical and operational level of the public client organizations to accelerate implementation of circular infrastructure projects with re-use strategy. In this chapter, the final conclusion of the research is formulated with following sequence: First the answers of all 5 formulated sub-questions are elaborated in the section 7.1 Then the MRQ of the research is answered within the section 7.2, using the answers of the sub-questions. Lastly, recommendations for implementing the suggested framework and conducting future researches are presented in the section 7.3.

7.1. Answers of sub-questions

SRQ1: What are the enablers and barriers for implementation of circular infrastructure projects with material re-use strategy within the public client organizations?

This sub-question was formulated within the literature review phase to find the recognized enablers and barriers by literatures, for implementation of re-use strategy in infrastructure projects within the public client organizations. To find the answer of this question, 7 lists of enablers and barriers have been reviewed in relevant fields to circular infrastructures with re-use strategy, such as: circular construction, re-use in construction projects, design for re-usability, and waste management in the construction projects. It found out enablers and barriers for implementing circular projects are normally being investigated in separate categories. These categories customized in this research for implementation of infrastructure projects with re-use strategy, by considering relevant ones to the role of the public client organizations. In general, 79 enablers and barriers have been identified (see Table 2.1) under 8 categories through a synthesis study. The 8 customized categories are as follows: *Knowledge/ expertise & experiences*/*Culture, behavior & communication/ Contracts, manuals & guidelines/ Organizational structures and business models/ Technics & technologies/ Collaboration with market parties & supply chain/ Re-use requirements & supports/ Financial aspects and economic supports*. Based on the reviewed literatures, the implementation of circular infrastructures with re-use strategy within the public client organizations, considered as re-use transition, which required to be accelerated. To provide the list of enablers and barriers useful in activating the acceleration phase of the re-use transition, it is required to distinguish the enablers and barriers that stem from or relevant to the tactical and operational level of the transition. The gathered enablers and barriers in this study are presented under three levels of tactical, operational and tactical & operational. The *tactical & operational* level points to the enablers and barriers, relevant to the both levels or exist at the borderline of the two levels. The gathered enablers and barriers from literatures used as input for semi-structured interview phase and shortlisted by the practitioners.

SRQ2: What are the potential organizational factors for implementing circular projects with re-use strategy?

Based on the reviewed literatures, formulation and use of frameworks is the best method for implementing the required systematic changes for accelerating the circularity transitions in the organizations. This sub-question formulated within the literature review stage of research, to gather the potential organizational factors for formulating the required framework. To respond this sub-question, a synthesis method conducted between the 9 circularity and re-use frameworks. Since, there is not any circularity framework focused on implementation of re-use strategy in the infrastructure sector, the 9 frameworks gathered from other sectors, such as built environment, construction in general and production. Common organizational circularity implementation factors have been collected from the 9 frameworks, which were compatible to be used for

implementing the re-use strategy as well. The collected factors are as follows: *Defining specific circularity strategy & targets, structuring collaborations with external parties, structuring internal& external communications, formulating guidelines and work units, knowledge development on the circularity strategy, adopting project management activities, investigating potentials for implementing the circular strategy, technical &organizational follow-ups/ evaluations on targets & strategies, organization extension and adaptation.* Under the implementation factors, various sub-factors also realized from frameworks with focus on re-use strategy, which can be considered as customized factors and detailed activities required for implementing this strategy. 9 circularity implementation factors and 15 sub-factors (re-use specific) are gathered in total and listed in the Table 2.3, as second result of the literature review phase. The factors used as one main component in the final framework. Also, the gathered sub-factors used as scientific input in formulating required organizational procedures for implementing re-use strategy, in the final framework.

SRQ3: How does the current procedures and guidelines at the tactical level for implementing circular strategy of re-use relate to the practices at the operational level?

This sub-question has been answered within the first part of the empirical study phase; the document review chapter. This question aimed for investigating the connection between tactical and operational level of the public client organization in implementing the re-use strategy. For answering this question, all sustainability and circularity documents with focus on re-use within tactical level have been reviewed, such as: internal & external advisory documents, agreements and directives. Important considerations formulated within these documents for implementing re-use strategy, collected and compared with methods used within the operational level, mentioned by the projects and pilot documents. The considerations categorized also under the 8 categories gathered from the literature review phase. Result of this comparison revealed the fact that implementation of re-use strategy at operational level, is not that much mature and systematically organized. The link between the two levels is very weak, and they are more fields of gap between the two levels than links. For instance, the re-use information is just stocked at the tactical level and not translated properly for operational actors. Also, the result of circularity pilot at operational level have not transferred properly to the tactical level, thus there is no coherent advisory document to be used for future projects. Also, some gaps identified within the operational level, between approaches in initiation phase and results at realization phase of projects. The gathered gaps from conducted comparison on documents are listed in the Table 3.6, under the 8 categories. To prevent the matter of subjectivity in identification of gaps and prioritizing them, the links and distinctions between the two levels also were investigated during semi-structured interviews. The gathered list of gaps used as input in formulation of the interview questions.

SRQ 4: What enablers and barriers can be identified to deal with the most important gaps between tactical and operational level in implementing re-use projects?

This sub-question is answered within the semi-structured interview chapter of this research, through conducting 18 interviews with actors within tactical and operational level of municipality, and contractors. To find the answer, list of prioritized important gaps between tactical and operational level, and important enablers and barriers in implementation of these projects, have been collected through qualitative data analysis method in this phase. The important enablers and barriers gathered from two qualitative methods of conducting a survey based on result of literature review phase, and analyzing result of open questions which asked during the interviews. The gaps collected and prioritized based on frequency of responses from interviewees, into 10 most important ones and under 5 top categories as follows: *1. Clear re-use target/strategy formulation & consistent follow-up/evaluation on targets, 2. Procurement method and contract model within re-use projects, 3. Communications and flow of information within and between the two levels, 4. Fragmented tactical/operational active sections and groups within departments & no explicit*

internal/external role with re-use expertise, 5. Culture and mindset for re-use, 6. Compatibility of provided designs at operational level with re-use strategy at tactical level, 7. Formulation of guidelines on re-use, 8. Lack of specific work procedure/ project stages for re-use, 9. Linking the supply and demand &availability of materials, 10. Low number of (successful) pilots and experience with re-use projects at operational level. The gathered enablers and barriers shortlisted separately in each of the two methods, based on their relevance to the top 5 categories, added together and linked to their relevant gaps. In general, 27 enablers, and 22 barriers linked to the top 10 gaps in this stage. The links indicate the barriers that cause each gap, and the enablers that are potential to overcome or mitigate the addressed barriers and fill the gap. The linked enablers and barriers to the top gaps, which have been addressed within the Table 4.4, are provide the main answer of the addressed research question. The addressed enablers and barriers, used in formulating the final solution for filling the identified important gaps.

SRQ5: What procedures should be followed to fill the gaps between tactical and operational level in implementing re-use projects?

This question has been answered in the solution development phase of the research. For filling the addressed gaps, the relevant barriers should be overcome or at least mitigated to high extent. To implement the enablers and overcome the barriers, specific organizational procedures formulated, using the circularity implementation sub-factors gathered from result of literature reviews and recommendations of interviewed practitioners. Procedures formulated for each organizational level (tactical, operational, tactical& operational level) separately. Also, the procedures suggested with either short-term or long-term targets based on the required time to facilitate the required resources for implementing them. Among all formulated re-use implementation factors, the top 3 ones which are addressing dealing with the top 3 gaps, recognized as the most fundamental and urgent factors for linking the tactical and operational level. The final framework formulated on the top 3 re-use implementation factors, which provide first steps for implementing the other factors in the future, including: *re-use target formulation, follow-up & evaluation*, structuring *internal/external communications* and *structuring the collaborations with external parties*. Result of implementing the recommended procedures are interrelated, hence the addressed procedures are linked together in the provided framework, as well. Strategic level was not in the scope of this research, however, involvement of this level is required for formulating and re-visioning the re-use targets. The links between the strategic level and procedures formulated for other levels, is also indicated in the final framework, such as; *link between procedures relevant to the target formulation factor and strategic level*. There is also a link between the three implementation factors in the suggested framework. After *developing the targets and evaluations*, to facilitate follow-ups between levels, the *communications* should first be structured, and then the *external collaborations* can be enabled. Following the procedures formulated in the suggested framework, can provide the required link between the tactical and operational level. For instance, according to the formulated framework, to make *re-use target formulation and follow-ups* more practical, this sequence should be more clear in the organization. Through following procedures formulated relevant to this factor, a cycle of *target formulation* by tactical level, *implementation of them* at operational level using the *GWW ambition web*, *analysis of progress by analyzers*, *monitoring by borderline actors*, and *periodic evaluations by tactical departments* should be provided. This sequential teamwork between levels will make a concrete link between them. Moreover, by following this cycle, *ambitious sub-targets can be formulated in projects at third level of the GWW webs and even full re-use can be facilitated* in the long-term. Integration of strategic level in the framework was required to complete the cycle of target formulation. The target formulation should be started from this level and the result of analysis of targets, should be transferred to this level again, to make re-visions on targets in required cases. The procedures relevant to the other factors are elaborated in the final framework which is indicated in the Figure 5.4.

7.2. Answer of the main research question; Research Conclusion

MRQ: How can the implementation of the circular infrastructure projects with material re-use strategy, be accelerated at operational level of the public client organizations?

In this research the main objective was identifying a solution for accelerating the implementation of circular strategy of re-use at operational level of the public client organizations. The circularity strategy of re-use has been locked at the tactical level of the studied public client organization and only implemented in few projects so far. Lack of a concrete link among tactical and operational level in implementation of re-use strategy, hinders implementation of more re-use projects at operational level and acceleration of re-use transition in the context of public client organizations. This research indicates that the mismatch between the tactical and operational levels in implementation of the re-use strategy is rooted in varied fields of gaps. The important gaps identified and prioritized in this research under specific categories, to fill them and accelerate the transition. Tackling such gaps require identification of the relevant barriers as causes of them and relevant enablers to overcome the barriers and fill the gaps. Some enablers are not detailed and easy enough to be implemented, and specific procedures are required to be formulated and followed by actors within each of the two organizational levels and actors in the borderline (e.g. managers and internal clients). Following-up such procedures to deal with the addressed gaps can be easier through using a framework. The required framework provided in this study for public clients, including formulated procedures and their relevant to re-use implementation factors. Among the existing gaps in practice, three gaps are more urgent ones, which are placed in the two top categories of '*culture, communication and behavior*' and '*contract, manuals and guidelines'*. In the provided framework, the top three gaps addressed by three re-use implementation factors of *target formulation, follow-up & evaluation, internal & external communication*, and *collaboration with external parties*. The re-use implementation factors and relevant procedures to them can be considered by the public clients as the first and fundamental steps in the pathway of linking the two levels in implementing re-use projects. The organizational procedures are interrelated in implementing re-use strategy, and result of implementing some procedures should be followed by work of actors in the same or another level. Some procedures are quite new and complicated for the public organizations, which require dedication of more resources and should be implemented in the long-term, using gained experiences and lessons from implementing procedures with short-term targets. To make the two levels of tactical and operational connected, intervention of the strategic level is also required, specifically for formulating and re-visioning the targets. The recommended framework to the public clients for accelerating the re-use transition is presented in the Figure 7.1. Department managers in each level of the public client organization can divide the suggested framework into separate advisory documents with detailed tasks for relevant actors in each level to implement the framework within the organization. Structuring the *communications, collaborations and target formulation stages* through implementing the procedures recommended in the presented framework and consistency with that, will prepare the organizational context for conducting more re-use activities, and link the tactical and operational level in implementing re-use projects. As a result, the re-use activities at the operational level of public client organizations will be more structured in implementing re-use strategy. With well linked tactical and operational level, and structured activities at operational level, the re-use transition will be facilitated and more circular infrastructure projects can be implemented with re-use strategy at operational level of public client organizations. Hence the implementation of circular infrastructure projects with material re-use strategy and re-use transition can be accelerated at operational level of the public client organizations, using the formulated framework. The presented framework also added to the body of knowledge in the field of re-use transition in the infrastructure sector. Acceleration of re-use transition in the infrastructure sector is the current topic in the academia and result of this research provides useful information on ***how*** this transition can be accelerated.

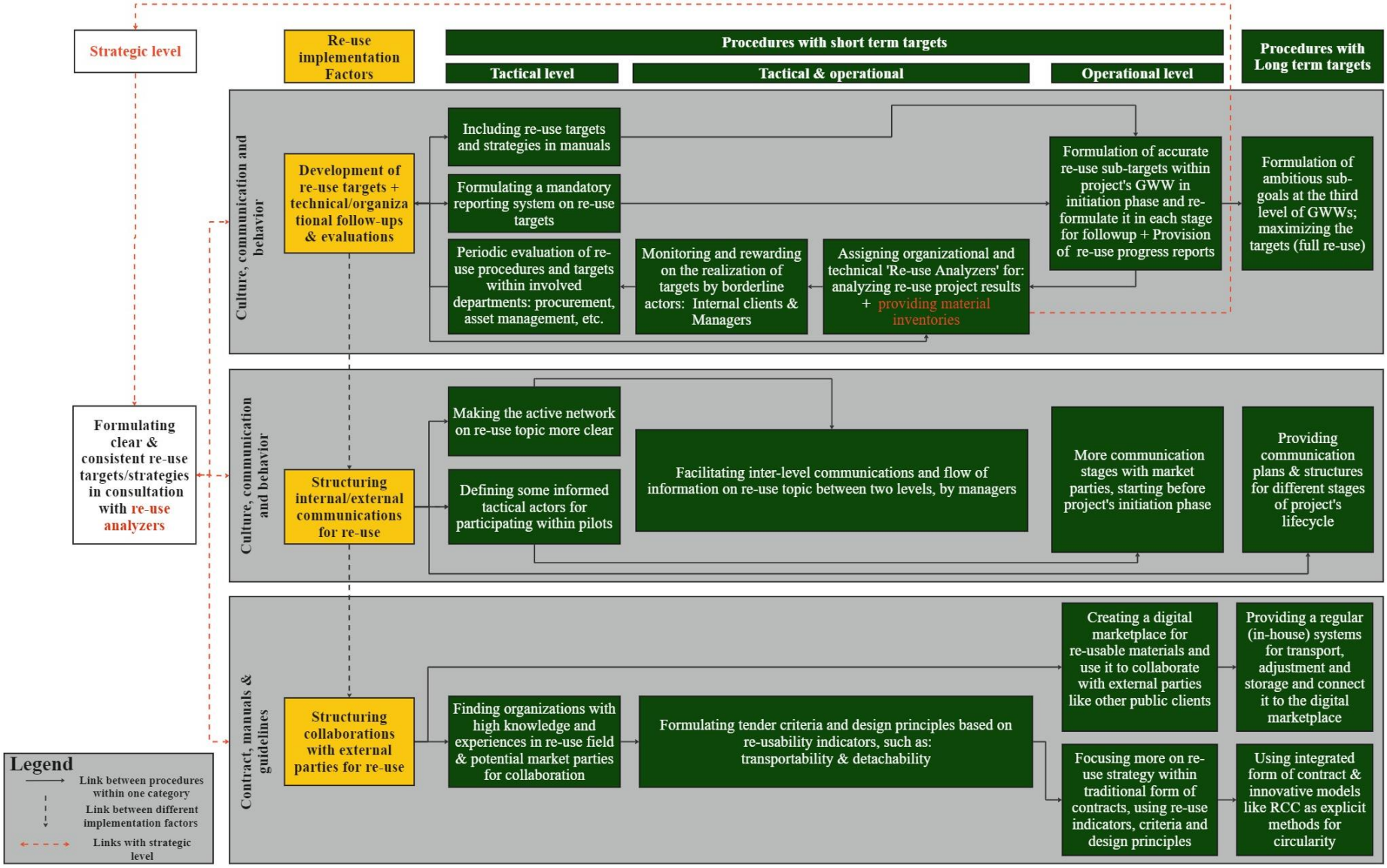

Figure 7.1. The Final framework for accelerating implementation of circular infrastructure projects with re-use strategy at operational level of public client organizations

7.3. Recommendations for practice and future researches

To accelerate the implementation of circular infrastructure projects with material re-use strategy, some recommendations are formulated for the municipality of Den Haag, other public client organizations and also the future researchers. These recommendations are presented in the following sub-sections.

7.3.1. Recommendations for the municipality of Den Haag

On top of the formulated framework, some recommendations are provided for the municipality of Den Haag to facilitate implementation of the framework in this organization and accelerate the re-use transition. These recommendations are formulated as follows:

- It is recommended to the cluster mangers in the IBDH (the main operational department), to add the suggested framework in this research into the '*Sustainable Commissioning Program',* in consultation with tactical actors responsible for this program from other departments (e.g. DBV, DSO), within the *Sustainability Knowledge Team*. The sustainable commissioning program and the recommended framework in this research can complement each other to connect the tactical and operational level in re-use transition within this organization. The integrated version of these two frameworks can also be generalized and used for reaching other sustainability and circularity targets within the municipality.
- It is recommended to the IBDH to start with assigning the re-use analyzers, to be able to provide the required material inventories and concentrate on target formulation with tactical and strategic actors. Then, the reporting system should be cleared in consultation with tactical actors, to enable both target formulation and reporting procedure, defined in the sustainable commissioning program.
- It is also recommended to the IBDH to train in-house re-use analyzers after gaining enough experience in working with external analyzers.
- The short-term and long-term targets within the presented framework can be defined considering the shared millstones between the network of 'infra 5 daagse' and the Dutch national circularity program (2030 and 2050). A recommended time-line in this regard is presented in the Figure 7.2.

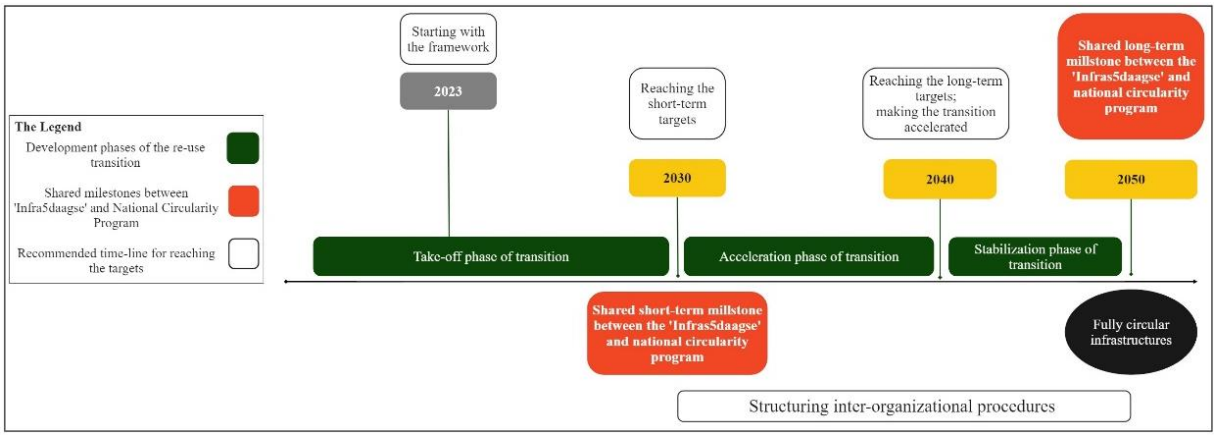

Figure 7.2. Recommended time-line for reaching the short-term & long-term targets

Also, it is recommended to the tactical & strategic departments of the municipality to:

- Customize the framework based on the resources and common procedures within the municipality.
- Dedicate a test period for the framework within the organization. At the end of this period, the number of tries to implement re-use strategy in the projects, and level of success with reaching the defined targets in each one can be checked to see the level of effectiveness of the framework.

- Discuss the practicality of the recommended procedures relevant to the other 7 re-use implementation factors in the preliminary framework presented in the Figure 5.3, as well. After assuring the practicality of those procedures through further decision making stages, they can be put into practice in the assigned levels to fill the rest of the fields of gaps.
- Check where are the exact gaps in implementation of other sustainability themes or circularity strategies, and customize the presented framework for filling the identified gaps.

7.3.2. Recommendations for other public clients & infra5daagse network

This research only focused on the internal gaps within the municipality of Den Haag.

It is recommended to other public client organizations to:

- Identify their internal gaps in implementing re-use projects, and then implement compatible parts of the presented framework to address and fill that gaps.

To address a circular solution for the national programs of renovating infrastructures, it is highly suggested to the active networks in them, like 'infra5daasge' to:

- Consider the network as the national context for re-use transition, and customize the framework to structure the inter-organizational procedures between the involved parties. Through *structuring collaborations & communications* between tactical and operational parties, *developing clear and detailed targets and evaluating* them, the re-use transition can also be accelerated in the national scale.

7.3.3. Recommendations for future researches

In this sub-section some recommendations are presented for the future researchers.

- Structuring the organizational aspects is only the primary step to accelerate the re-use transition in the infrastructure sector. Future researchers can conduct their studies on technical fields and try to develop more efficient and effective technical solutions for operational level of the transition, to re-use materials in the infrastructure projects.
- This research only focused on identification of gaps and providing solutions to implement re-use strategy within the public client organizations, however, implementation of re-use strategy involves different parties in the market, such as contractors and supplier of reclaimed materials. Investigating role of market parties and inter-organizational gaps in development of circular infrastructure projects with re-use strategy, is highly recommended to the future researchers.
- Qualitative analysis on the realization of re-use targets, mentioned as important part of the presented framework, without suggesting the most optimal quantitative method for conducting the analysis. Exploring optimal quantitative methods for doing analysis on result of re-use projects can also be another topic for future researches in this field.
- This research only investigated the tactical and operational transition levels, however the final solution provided in this research also integrates the strategic level. Exploring strategic level of organizations and trying to add a complete reflective level as mentioned in the Transition Management Framework, is also recommended for the future researches.
- Lastly, this research only addressed implementation of the circularity strategy of re-use, which has higher value. It is recommended to the future researchers to investigate other circularity strategies such as recycle, refurbish, etc. in development of the circular infrastructure projects with no possibility of re-use, by addressing the pros and cons of each strategy in projects.

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Appendix A. Literature review

AppendixA.1. Procedure of providing the list of enablers and barriers

Since they are not many experiences with implementing of re-use strategy in the infrastructures industry yet, there are not many literatures on enablers and barriers in implementing specific approach of re-use in infrastructure sector. Hence, these enablers and barriers have been gathered from 7 different lists of enablers and barriers from different relevant fields, which are addressed in the Figure A.1. These fields have commonalities with re-use strategy or are important part of implementing that. As an illustration, the enablers and barriers in the field of implementing circular construction projects is the field which have commonalities with enabler sand barriers in implementing re-use strategy in infrastructure projects. Moreover, the filled of circular design is the subordinate of re-use strategy, hence all enablers and barriers in this field are common with enablers and barriers in implementing re-use strategy.

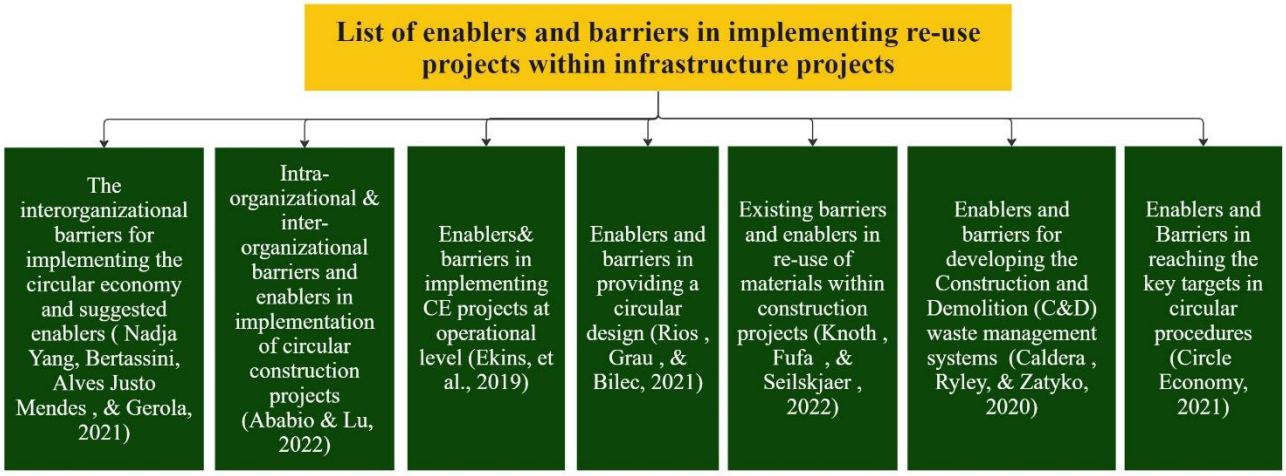

Figure A.1.Illustration of the different fields from which the list of enablers and barriers for implimenting re-use strategy have been gathered from

Moreover, the list of enablers and barriers in each field is not specifically formulated for public clients. In each field, the enablers and barriers are formulated within the construction industry in general, which are linked to specific group of actors like designers, contractors, governments, clients, developer, etc. (Rios , Grau , & Bilec, 2021) (Ababio & Lu, 2022) (Circle Economy, 2021) (Caldera , Ryley, & Zatyko, 2020) (Knoth , Fufa , & Seilskjaer , 2022) (Ekins, et al., 2019) (Nadja Yang, Bertassini, Alves Justo Mendes , & Gerola, 2021). To relate the enablers and barriers with their context organizational/transition level for further analysis, the relevant ones to the role of public client organizations have been selected and gathered, to make a customized list for public clients (Rios , Grau , & Bilec, 2021).

Appendix A.2. Reviewed Circularity Frameworks

The reviewed circularity frameworks in this study are listed and explained as follows:

1. ***The BECE framework***

The framework of BECE is a procedure oriented framework proposed to organizations in different sectors to make a concrete structure for implementing circular projects (Mendoza, Sharmina , Gallego-Schmid, Heyes , & Azapagic, 2017). A mix of circular projects steps from “Eco-design” framework and

organizational "strategic planning" stages from sustainability implementation framework of "Backcasting" is suggested in this frameworks to be used as a guide for implementing circular projects (Mendoza, Sharmina , Gallego-Schmid, Heyes , & Azapagic, 2017). The mixed approach of this framework and its focus on both planning and execution activities, made it a concrete tool for "linking the tactical and operational level" for implementing circular projects (Mendoza, Sharmina , Gallego-Schmid, Heyes , & Azapagic, 2017). On tactical side of this framework, "defining specific circularity visions and targets", and on operational side" defining clear ambitions" are suggested in first place within this framework for (Mendoza, Sharmina , Gallego-Schmid, Heyes , & Azapagic, 2017). Zooming into the "Backcasting framework", periodic "engagement of stakeholders" is defined as the most crucial step in implementing "innovations and changes" in the organization, like circularity transition (Quist , 2013). Structuring communication stages among them through using definite "participatory methods" like workshops is suggested by this framework for formulating, reformulating and implementing circular targets and follow up the results (Mendoza, Sharmina , Gallego-Schmid, Heyes , & Azapagic, 2017).

2. The circular construction framework

The Circular construction framework is a general circularity framework developed to be used for implementation of different types of construction projects with circularity targets (Tobben & Opdennaker , 2022). This framework recommends to implement the circular strategies within projects through following three specific stages of "gaining required knowledge" regarding the specific strategy which is going to be implemented, focusing on that in the project's "initiation phase" and integrating it within the activities related to management of project targets for adopting the "project management" method (Tobben & Opdennaker , 2022). For knowledge development it is suggested to integrate "general strategies and targets" within manuals to be used in the operational stages (Tobben & Opdennaker , 2022). Within initiation of project it is required to define the specific "circularity ambitions" according to this framework (Tobben & Opdennaker , 2022). provision of "detailed guidelines" is also suggested within this framework to use as blue print in different stages of projects like "construction from scratch, deconstruction, re-built", etc. (Tobben & Opdennaker , 2022). Structuring the "communications" between different project actors is one important factor for "customizing project management activities" within circular projects, according to Tobben & Opdennaker , (2022). Also, zooming into compatible "procurement and project delivery method" with this form of contracts, use of more "integrated form of contracts" is suggested by this framework, specifically the "Construction Team" delivery method, suggested as the best model for circular practices (Tobben & Opdennaker , 2022).

3. The BLOOM (BLOEI) framework

The Bloom or BLOEI framework is a general circularity implementation framework, which provides an overarching vision for implementing different circularity strategies in the construction activities (RVB, 2022). This framework is formulated by the "Netherlands Governments Real state Agency (RVB)", to different target groups of "commissioners, developers, owners" in the whole construction industry (RVB, 2022). This framework is implied on considering general "elements" of implementing circular projects, for any kind of "re-built or new construction" projects, and developing detailed and "customized work units and guidelines" under each dimension (RVB, 2022). These "elements" are: investigating of potentials for implementing circularity strategies like re-use and recycle in existing projects, selection of more circular an environment friendly materials (bio based/reclaimed, etc.), starting with circularity from design procedure, digital collection of project information and spreading that through communication stages, and conducting projects through collaborations to better manage the financial risks (RVB, 2022).

4. The FCRBE re-use guideline

The FCRBE is a framework a framework from the construction sub-sector of building environment, which is exclusively formulated for conducting projects using the circular strategy of re-use (Geerts, Ghyoot, & Naval, 2020). This fraemwrok provids detailed steps to follow by the projects commissioners, which are clearly and step by step explained (Geerts, Ghyoot, & Naval, 2020). The FCRBE method recognized the re-use projects with two specific stages of "material reclemation" and "implimentation of a recliemd material" in same or another project (Geerts, Ghyoot, & Naval, 2020). Breaking down such specific project stages and provide a detailed guide for commissioners and specifically actors within operational level is a useful method for faciliating implimentation of such projects which is doen within this framewrok (Geerts, Ghyoot, & Naval, 2020).Such guideline can be reformulated for other subsectors of construction like infrastructure projects and also customized within each specific public client organziaton. As mentioned in the priovious sections, such detailed guide should be formulated by tactical actors to be used in the operational level (Loorbach, 2010). According to this framework, the first factor which should be considered for implimenting re-use projects is formulating "specific re-use targtes and strategies" by commissioner organziations and defining "clear ambitions fo each specific project" from the "initiation phase" (Geerts, Ghyoot, & Naval, 2020). Also, one specific stage for making the formulated targets reachable is constantly "Investigating the re-use potentials", like looking for re-usable materials in existing assets, which called conducting the "reclamation audits" (Geerts, Ghyoot, & Naval, 2020) .

5. The Re-use collaboration model

The re-use collaboration model is a specific framework formulated for conducting collaborations among involved actors in projects with specific circularity strategy of re-use (Trabulsi & Sofipour, 2020). The main suggested factor by this framework for implementing high quality and successful re-use projects is "structuring collaborations" through formulating a model, between different involved actors in each stage of the "project lifecycle" to conserve interests of all actors, assure realization of all ambitions and prevent any conflict (Trabulsi & Sofipour, 2020). Each stage of project require collaboration between specific actors for carrying and following up specific tasks, as an illustration, involvement of actors like designers and re-use consultant is required in the initiation phase for formulating "values and targets of projects and planning" for re-use (Trabulsi & Sofipour, 2020). By collaboration model, need for both structured and regular internal/external "communications" and use of "integrated contracts" is mentioned by this framework (Trabulsi & Sofipour, 2020). Such model can be customized for infrastructure projects and be used by public client organizations to organize inter-organizational and intra organizational collaborations in each stage of project's lifecycle.

6. The RISE framework

RISE is stands for categories of indicators in the fields of "Research & Realization", "implementing circularity strategies", "Support" and "Enabling" for evaluating projects with circularity strategies in the whole "construction and demolition sector" (Superti , Houmani , & Binder , 2021). This framework present indicators for evaluation of both organizational procedures and technical aspects of projects for accelerating implementation of circular projects in the "C&D sector" (Superti , Houmani , & Binder , 2021). Evaluation of "quality and quantity" of different activities in the procedure of implementing circular strategies like "research activities, project execution", and support/enabling activities like require processes, "financial and human resources", different documents and people performance can be facilitated using this framework (Superti , Houmani , & Binder , 2021). Such evaluative approach is also useful in conducting re-use projects, to check the quality of results in projects and organizational procedures constantly.

7. The 8 Test Framework

To fully realize the targets of circular transitions in the context of each organization, it is always required to test the intra-organization procedures in each transition stage, which can be done using the "8 test framework" (Philipp, Kühl, Braun, Dixon, & Herrmann, 2022). In using this framework, which is formulated with the target of following up the circular transition procedure within an organization, the 4 elements of used "strategies", used "structure", implemented "process" and involved "people" should be tested regularly (Philipp, Kühl, Braun, Dixon, & Herrmann, 2022). For testing the organizational procedures against these elements, the "effectiveness of new organizational model" should be in 8 specific fields (Philipp, Kühl, Braun, Dixon, & Herrmann, 2022). Such test procedures can be very useful for following up the re-use transition procedure within the public client organizations as well. The 8 test framework is indicated in the Figure A.2. as a sample of follow up model in implementing circularity strategies. The figure is adopted from the model formulated by Philipp, Kühl, Braun, Dixon, & Herrmann, (2022). In the adopted version, each of 4 elemnets are put in the context of their relevant organziational model.

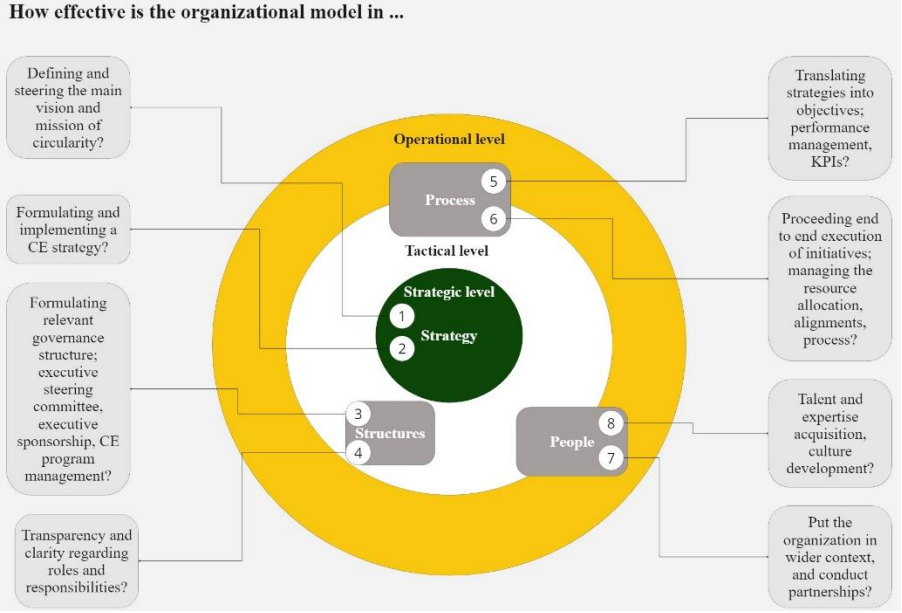

Figure A.2. Organizational 8 steps framework (Adopted from; Philipp et al., 2022, P:9)

8. The Bridge circularity assessment framework

The "Bridge circularity assessment framework" is a practical tool for evaluating the level of circularity in bridge and viaduct projects, which can also be customized and used for other type of infrastructure projects (Coenen, 2019). This framewrok propose some circualrity indicators to be used in "design" and development of new projects and also evaluating the circualrity level of existing projects (Circle Economy, 2021)(Coenen, 2019). These indicators can which also be used as" reward criteria" for suggested designs, are formulated also exclusively for "re-usability" of assets as; "transportability, low uniqueness and diassembility" (Circle Economy, 2021)(Coenen, 2019). Such indicators, difine the "minimum level of circualrity requirements" in projects (Coenen, 2019). The mentioned re-usability indicators, can be used as required minimum level of re-usability of each formulated design for circualr infrastructure, and should be combined by a specific numeric target provided by public client organziation to conduct the evaluation procedure.

9. Strategies of implementing circularity in public client organizations

For accelerating the implementation of circularity strategies within the public client organizations in general, some strategies are suggested by Klein, Deutz, & Ramos, (2021) to impliment in these organziations. The aim of these strategies is providing the context and implimenting chanes, interms of "culture inside organziation and Governance system of organziation" (Klein, Deutz, & Ramos, 2021). These strategies which can also be adopted and use exclusively for implementing re-use approach with public client organizations, are formulated in 3 fields of "strategic initiatives", "human resource management" and "communication & assessments strategies" (Klein, Deutz, & Ramos, 2021). Defining "organizational" and technical analyzers for circularity activities, defining specific "circularity sector for steering circularity activities", reporting and "archiving results" for evaluation, "involving circularity specialists" and "gathering periodic reports and feedbacks on circularity practices", are samples of suggested strategies by Klein, Deutz, & Ramos, (2021), for implimenting circualrity strategies in POS. The Table A.1. able below represents all these recommended strategies based on (Klein, Deutz, & Ramos, 2021).

Table A.1. Strategies for implementing CE in POs

Category of Strategies	Strategic initiatives (for managers)	Strategies for management of Human Resources	Strategies for conducting evaluations and communications
Strategies	Combining CE activities into provided strategic and action plans, "policies, manuals, etc. "in strategic level" Determining CE actors ("CE champions") in each level Determining a separate specific sector to conduct CE activities and archive the information Determine specific groups to analyze "organizational" aspects and problems in "CE" practices	Acquisition of talents and experts with "skills or experiences in CE field" and managing of relevant ideas (Making everything in house) Holding knowledge sessions and "training workshops on CE" procedures Use of labels with information on components for operational actors (how to –reuse, etc.) Provide "policies" and manuals for "common resource management" regulations Providing prizes and small wins for actors	Assign assessors and measurements methods for "organizational CE performance" "Steering Energy efficiency audit" Developing circular "resource management system" Developing feedback collection methods and surveys for "CE practices" among actors on Holding periodic" conferences and events" to share collected "knowledge" from different steps of experiences Publishing periodic organizational CE progress "reports"

Appendix B. Document review

Appendix B.1. General Work procedure within the Municipality of Den Haag

The complete work procedure which is followed within the municipality of Den Haag in conducting infrastructure projects (including sustainable projects), is illustrated in the Figure B.1. In projects with sustainability themes, sustainable targets will be defined in the initiation phase of project.

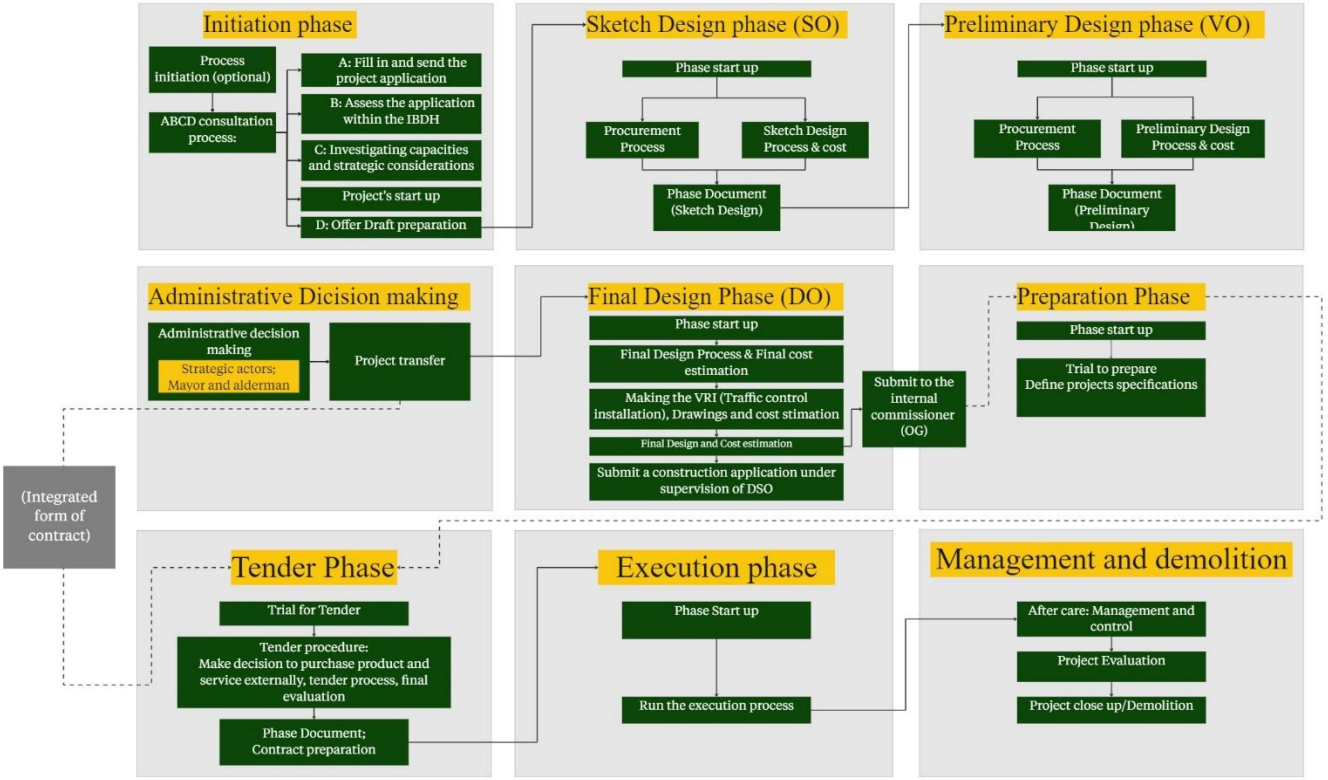

Figure B.1.General work procedure in the municipality of Den Haag (Adopted from Den Haag internal document, 2023).

Appendix B.2. Sustainable commissioning program

Figure B.2., indicates the formulated stages, procedures and suggested tools within the sustainable commissioning program. This framework is only focused on activities within operational level and specifically different stages of project's lifecycle.

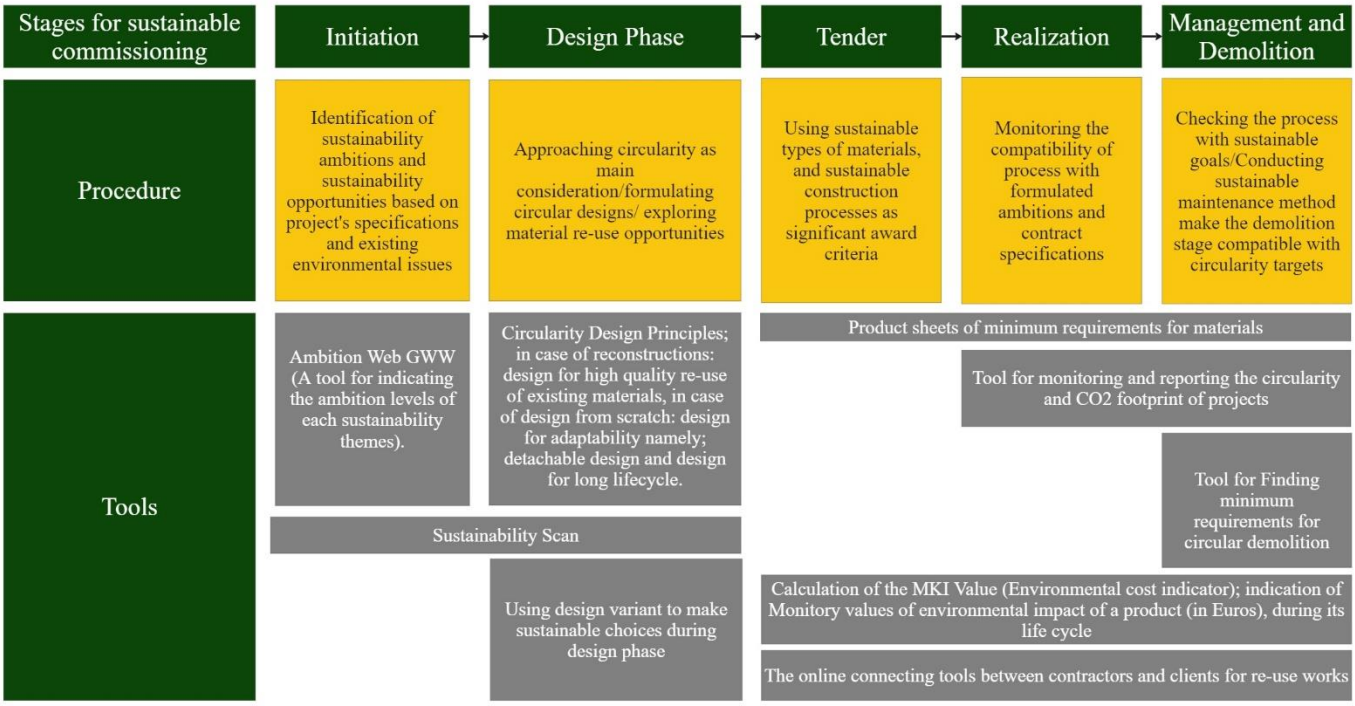

Figure B.2. Sustainable Commissioning Program (Adopted from Den Haag internal document, 2023).

Appendix B.3. Sustainability ambition web

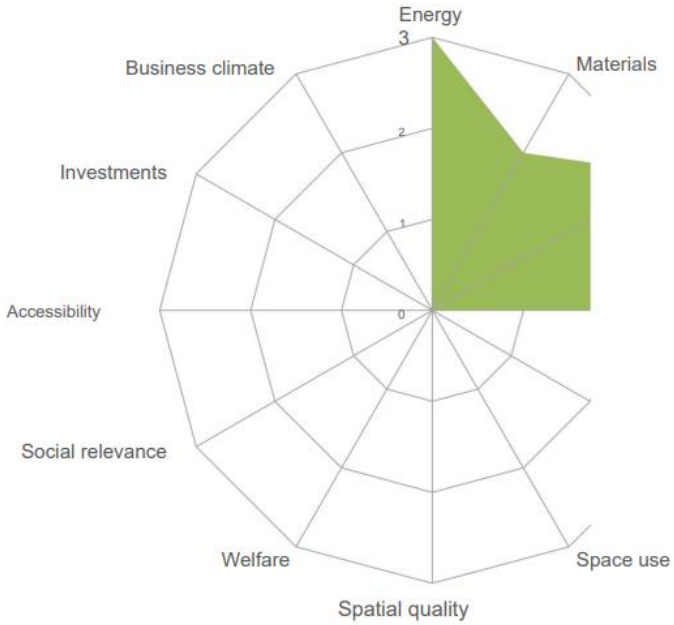

Figure B.3. A sustainability ambition web (GWW), with different themes and ambition levels (retrieved from the internal sources of municipality of Den Haag, 2023).

Appendix B.4. The advices on using the RCC method

In the process of implementing the RCC strategy, some important hints should be accompanied as well to assure the quality. Important advices on using the RCC method in projects, are listed in the Table B.4.

Table B.4. Important hints in implementation of the RCC method for circular projects

NO.	Important hints
1	**Defining the tender method at early stages;** Less design works should be conducted before to the tender and more should be done in collaboration of the contractor.
2	**Provision of adequate support and capacity to implement the method**; The support and capacity should be provided like adjusting work procedures.
3	**Clarification of the goals and working methods**; Develop work procedures and anticipate risks and develop mitigation plans
4	**Concentration on provision of right composition of actors for project**; The project team should include curious, motivated and innovative actors.
5	**Dedicate the required resources to the project**; Adequate number of human resources, time and budget should be dedicated, resources should be managed and prioritized.
6	**Define and consult with the steering group in adjusting the procedures and organizational structures**; A concrete relation between technical group and steering coalition should be developed.
7	**Concentrate on communication plans regarding the implementation of the tender method**; Can be combined in the regular meetings or extra plans can be formulated to gather all innovative ideas.

Appendix C. Semi-structured Interviews

Appendix C.1. Interview protocol & questions

The main aim of the conducted interviews were two folds; first gathering the information regarding existing barriers and enablers and & most important fields of gap between the tactical and operational levels of the public client organization of Municipality, in implementing re-use projects which are most urgent to be filled. The method used to gather these enablers and barriers and gaps in practice, were not only asking open questions, but also asking questions on gathered lists of enablers and barriers and list of gaps from literature review and semi-structured interviews, respectively. The interview themes are formulated as follows based on the gathered results from the literature review and document review phases, after clarifying the themes of interview the relevant interview questions formulated under each theme.

The four themes that have been considered for this interview are as follows:

Theme1: General expert opinions regarding the re-use projects in Infrastructure sector

This theme formulated based on the theoretical bases on circular projects with re-use approach, gathered in the first part of the literature reviews. The aim of formulating this theme was gathering more information on the re-use projects in infrastructure sector, current situation with re-use transition and specifications and certain stages within these projects.

Theme 2: Important barriers in implementing re-use projects and enablers of implementation of re-use strategy in the operational level of public client organizations

This theme formulated based on the list of enablers and barriers gathered in the literature review phase. The aim of formulating this theme was gathering the list of important enablers and barriers for implementing re-use strategy in projects. This list gathered using two different methods. First, interviewees asked to provide some enablers and barriers, by some open questions. Then they asked to prioritize the list of enablers and barriers gathered from result of literature reviews, using a Likert scale. Result of both methods analyzed together to reach the final list of enablers and barriers.

Theme 3: Distinction and links between procedures at the tactical level and practices at operational level of the public client organizations regarding implementation of the re-use projects

This theme formulated based on the comparison conducted in the document review phase between tactical and operational level in re-use practices, and asking them about the most important gaps they identified in the municipality organization between tactical and operational level in implementing re-use projects. The main aim of formulating this theme was to check the gathered gaps in document review with practitioners to prevent the matter of subjectivity in identifying the gaps and prioritizing the identified gaps, to list the most important and urgent ones to be filled. questions under this theme only asked from the internal interviewees.

Theme 4: Recommendations, suggestion for linking the two levels and implementing more the re-use projects

This theme formulated based on the gathered list of circularity implementation factors. The aim of formulating this theme was gathering some recommendations from interviewed internal practitioners and contractor/suppliers, to fill the identified gaps. These recommendations aimed to be added to the identified re-use implementation factors from literature reviews, to make the final list of suggested procedures for implementing re-use strategy at the end.

Questions are formulated from all 4 mentioned themes and for conducting the survey in theme 2, the list of enablers and barriers given to the interviewees after the interview session via an email, and asked them to rank the lists through using the provided 4 scale Likert scale, from not important to highly important scale, and adding missing enablers and barriers under each category.

The formulated interview structure is elaborated as follows:

Introduction stage:

Prior than the interview session, all interviewees received an informed consent form via the invitation email and they sent back the fill in and signed forms. In this phase, different categories of practitioners have been invited and interviewed. The **categories of interviewees** were: the municipality internal actors in tactical level, the municipality employees at operational level and the contractors/suppliers with re-use experiences. At the interview session, first the introduction stage conducted. In this round first the researcher introduced herself completely, then the research focus and aim of the interview explained briefly. Also, the specific terms used in this research, like tactical and operational levels, re-use, etc., explained for them briefly to check that both interviewer and interviewee are at the same place. The interviewees asked for a permission for recording the interview session as well. Then the Interviewees asked to introduce themselves by telling their exact role, main tasks within the organization, years of experiences within the role and municipality in general. Only for Municipality employees (internal actors), also asked to say their organizational department, the organizational level of their department (tactical/operational), and whether the works they carry out in their role are most tactical or operational.

General questions stage:

A same set of general questions asked in this stage, which are formulated for all interviewee categories.
The general questions which are formulated under theme 1 & 2 are as follows:

Theme 1.

- What is the current situation regarding the implementation of re-use projects in Infrastructure sector and re-use transition in your opinion?
- What are the main specifications of re-use projects? What are the main stages in implementing the re-use projects?

Theme 2.A. Open questions

- What are the existing barriers in implementing the projects (maintenance or new development) with re-use approach in your opinion?
- Do you think the barrier(s) that you mentioned is at tactical level or operational level?
- What are the enablers and important considerations for accelerating implementation of the re-use projects and overcoming possible barriers in these projects?
- Do you think the enabler (s) that you mentioned is at tactical level or operational level?

Theme 2.B. The survey

After asking the open questions, the interviewees informed about the list of enablers and barriers and they will have received through an email after the session, to save the time of interview session and provide more time for them as well to check the list. The two questions presented below also sent to them to answer based on the list of enablers and barriers that they received.

- Do you agree with the listed important aspects and enablers steps? Please rank it using the provided Likert scale based on level of importance of each enabler and barrier.

- What are the missing barriers and enabler aspects in your opinion within this list?

Tailored questions for each category of interviewees:

At the third stage, the tailored questions asked from each specific category of interviewees. The customized questions for each category are listed as follows:

Category 1: Tactical actors within the Municipality

Theme 3.

1. Are you aware of the organizational re-use targets and re-use strategies within the Municipality? If yes, please explain.
2. Which exact departments include the tactical level of the Municipality organization? Which are the active tactical sections and teams in circularity and re-use projects within the Municipality?
3. Are you aware of existence of documents, guidelines and result of pilot projects on specific approach of re-use (circularity) within the Municipality? If yes which documents and projects? please explain/give an example.
   - Were the pilots successful projects in your opinion? please explain.
4. What do you think regarding the relevance of the procedures and guidelines at tactical level and practices at operational level in the field of implementing circular strategy of re-use within projects?
   - What are the distinctions and links among them in your opinion?
5. To what extent you think there is a coherent flow of information, reflective procedures, and follow up plans between results of the re-use pilot projects, tactical level and practices within the operational level of the Municipality? please explain.
6. Have you ever heard about new roles such as internal and external re-use ambassadors, innovation managers or transformation agents within this organization? Are there any explicate roles like these within this organization to implement and follow up re-use projects? Do they have active participations within projects?
7. Is there a specific work procedure within this municipality to implement re-use projects? If no, to what extent you think the organizational culture and work procedures within the Municipality, is adoptable to make systematic changes and transitions possible?
8. To what extent you have clear re-use target formulation, and regular follow up/evaluation plan to reach them within projects in this organization? Do you know about formulation of GWW (sustainability ambition webs) and their follow up procedures on re-use targets within project's sustainability reports? please explain briefly.
9. To what extent the circular and specifically re-use design principles (like DfD) are integrating in the projects within the Municipality of Den Haag?
10. Which collaboration and procurement methods are normally used within re-use projects? Are the innovative and specific procurement or contract delivery models being used in these projects? please explain / give example(s).
11. Is there a coherent participation and communication plan between stakeholders in the circular (re-use) projects from the initiation phase? please explain briefly.
12. What is the most important gap in practice in your opinion in implementing of re-use projects?
13. In which of these specific fields you think there is a higher gap within the Municipality, regarding implementing re-use projects:

Technical feasibility (technical and technologies)/ organizational procedures and structures/ organizational culture/ behavior and communications/ knowledge, expertise and experience/ policies and guidelines,

regularity bases/ extra requirements and supports/ financial aspects and support/ collaboration with market and supply chain. Please explain briefly.

Theme 4.

14. What are your recommendations/suggestions to implement more infrastructure projects with re-use theme in future and accelerate this transition? What important aspects, elements, considerations or steps should be considered and followed for implementing re-use projects?
15. How a better link between tactical and operational level of Municipality can be provided to better integrate the re-use at the public client organizational work procedures and more re-use projects in the future?

Category 2: Experts at the operational within Municipality

All questions asked from actors in this category were same as questions asked from actors under category 1, except for questions which specifically referred to their organizational level. For these questions they asked to answer questions regarding the practices in operational level instead of tactical.

Category 3: Re-use Contractors and suppliers

The questions under theme 3 have not asked from interviewees in this category, since they did not have information from procedures within organizational levels inside the municipality. Instead other questions formulated relevant to the topic and near theme 3, for this category. They also asked to provide their recommendations for filling the gaps in practice at the end, under the theme 4.

1.To what extent the re-use specific activities (supply of reclaimed materials, conducting reclamation audits, transport and storage of materials, etc.) are being requested form you by the municipality and other public clients?
2.How these re-use specific activates are being requested from you by the municipality and other public clients? please explain based on the activities within your company.
3.What are the main challenges and enablers in execution (and operation& maintenance) of re-use projects?
4.In which of these specific fields you think there is a higher gap within the Municipality, regarding implementing re-use projects:
5.Technical feasibility (technical and technologies)/ organizational procedures and structures/ organizational culture/ behavior and communications/ knowledge, expertise and experience/ policies and guidelines, regularity bases/ extra requirements and supports/ financial aspects and support/ collaboration with market and supply chain. Please explain briefly.
6.Do you know about possible uncertainties and dilemmas within re-use projects? If yes, do you know how to deal with them?
7. Is there any specific framework/ work procedure within implementation of re-use and circular projects that you follow?
8.Which collaboration and procurement methods are normally used within re-use projects? Are the innovative and specific procurement or contract delivery models being used in these projects? please explain briefly.
9.Are you aware of any regular ambition follow up and evaluation plan for circular or re-use projects? If yes, please explain briefly.
10.How is the supply and demand procedure and link between them in the material re-use projects?
11.What is needed to be done by Municipality as a public client organization to balance the demand and supply and link them in this specific approach?

12.Is there a coherent participation and communication plan between stakeholders in the circular (re-use) projects from the initiation phase? please explain briefly
13.What is the most important gap in practice in your opinion in implementing of re-use projects? In which of the two fields of the technical feasibility or organizational procedures you think there is a higher gap?

Theme 4.

13.If you are working with other public clients like other Municipalities on re-use projects:
- What are the work procedures look like in the re-use projects? Are they different from the traditional projects? please explain briefly.
14.What are the most important lessons learnt from those projects that you can suggest to the Municipality of Den Haag as your client to implement more infrastructure projects with re-use theme in future and accelerating this transition? What important aspects, elements and steps should be considered specifically?

Closing phase:

In the closing stage, interviewees asked to add any other point they want to mention regarding the topic. Also, it addressed that some questions may asked from them later, and they approved. At the end it mentioned that the transcript of interview will be send to them, if you want to verify before anonymizing that and use as data for research.

Appendix C.2. Quotations from anonymized transcripts

Tables below represent quotations relevant to 2 interview themes of *'General expert opinions & Links and Distinctions between tactical and operational level*' gathered from anonymized transcripts. Each quotation is mentioned under each relevant code released from Atlas.ti data analysis software. The quotations are represented with anonymized names of interviewees in this tables, which are indicated as interviewees codes.

Theme 1: General Expert opinions

Interviewees code	Quotations	
	Code: General Current situation with re-use transition	Code: Main stages& specifications of Re-use projects
DHT1		"Reclaimed materials *have dirt and they are varying in shapes*, hence *cleansing of dirt and adjustment of shapes" is required*
DHT2		*on the project level we work with some of those tools and we have quite good evaluation and follow up for next project*
DHT3		*guarantee of material quality*" *is important*
DHT4		*High costs of transactions, transportation & storage among the wide network* involved within project
DHTO2		*at the beginning they are high ambitions for re-use and everybody say yes we should do that since that's good for environment but later on they drop the targets*
DHO2	*"In recent years you see different approaches which should be part of the design process as well…and now we also want parts of the design done by contractors in these projects*	
DHO3	*-If the product is good in shape will not be broken or thrown away or whatever, we re-use it*	" *we have mostly re-use in maintenance of roads and not new designs and new concepts".*
DHO4		"Reclaimed materials *have dirt and they are varying in shapes*, hence *cleansing of dirt and adjustment of shapes" is required*
SC1	*re-use is very important nowadays within Netherlands and clients have very high demands for re-use* - *higher knowledge and experience is on the contractor side"* according to the interviewee	*they have evaluation of that process during the works, so at the start of the tender you require to give a certain calculation of your numbers".*
SC2	*within the last 4.5 years' municipalities and other governmental people who makes decisions are much more aware of*	

	using secondary materials which is also because of the international goals	

Theme 2: Links and Distinctions among tactical & operational level in implementing re-use strategy

Interviewees code	Quotations
	Group: Distinction between levels- Field of Re-use knowledge, expertise & experiences Code: Lack of Knowledge & expertise in both levels on re-use projects
DHT1	*"one important gap is on nowledge of people about what is possible or how can come in use or how can be make it part of a project"*
DHT3	experties is too low "
DHTO2	*I have never heard of that so I do not think they are any within orgnziation*
DHTO4	*it is needed to not only make a design detachable but also lasts for long time*
DHO1	*In general it's still very hard to re-use materials and I think cause for that is mainly there is a lack of knowledge about things are available to re-use and its also way of thinking in your design that you start your design with the materials as basis and you do not design as you always do* - *I have never heard of that so I do not think they are any within orgnziation* - *in case experties are available there is not enough experiences*
Interviewees code	Quotations
	Group: Distinction between levels- Field of contracts manuals and guidelines Code: Responsibility of internal clients in asking for integrating re-use requirements in projects
DHT2	*"If we as internal clients does not take the assignement to do so and do not have the money and the task to do it and do not see this we do not know this and we can not tell the engineering departmants to work like this so, that's challeng"*
DHTO2	*I know a guideline that my internal client should state to me"* to implement re-use activities, - *at the beginning of projects there can be active participation for re-use if you make it happen as manager, you have to pull them in your project"*
DHTO5	*To think about reuse and to implement the incentive is not coming from the form our internal client from DSO, they do not give us requirements like that. they give us a set of requirements and then we start from the requirements with the design phase an But it's not one something about sustainability*
DHO3	*the internal Commissioner has to ask us, what can we do for sustainability if he doesn't ask us, we do the minimum"*

Interviewees code	Quotations
	Group: Distinction between levels- Field of Collaborations with market and supply chain Code: Linking the supply and demand/availability of materials
DHO2	*:" we making little steps in the whole market, but it's hard because we have to make a match between ready to re-use in actual new project and it is beautiful chance to re-use but it's also hard because its limit your options within the projects*
SC1	*-Planning wise its obviously not prossible to combine all the material ro remove from a project and the new material you need in the project with the same transport*

SC2	*The required materials are not always available and it is as a gap in supply and demand* - *availability of material in the region for example we tried to re-use a lot, but they do not always in the size we need, so its has to be high quality material and its most of the time not*

Interviewees code	**Quotations**
	Group: Distinction between levels- Field of Collaborations with market and supply chain Code: More involvement of market parties for re-use
DHT3	*there is a high gap in active participation from all parties and collaboration between them*
DHTO3	*-there is a high gap in active participation from all parties* *- we do something but its has to be much faster that we are doing now and we have to do this not only by ourself but also the contractor and municipal together*
DHO1	*what they like to do in municipality and that's what they do best because we have the knowledge is having influenec on the design, but the danger is that you continue doing what you always did so it's very hard to do something new in that and so changes can be made but take a lot of time*

Interviewees code	**Quotations**
	Group: Distinction between levels- Field of Collaborations with market and supply chain Code: Formulating re-use specific requirements
SC1	*The, municipality well explain what is required and in tender document. They already have certain requirements where re- use activities are requested. like the new bridge that we want you to build need to have certain amount of reused concrete. For instance you need to limit transport movements*
SC2	*and we as contractor/supplier know they always want to be circular about every products so alsmost 100 percent of the time we think about to offer it and its not always asked but we know that the municipality wasnts it".*

Interviewees code	**Quotations**
	Group: Distinction between levels- Field of culture, communication and behavior Code: Stakeholders engagement
DHT1	*there is communication plan with stakeholders but not specific for circularity or sustainability, its more part of the total process and we do not address it specifically for re-use projects*
DHT2	*we have coherent communication approach for all our projects but it is not mainly focused on circular or re-use, we have that approach where we allow much participation and we value commitment of a lot of stakeholders in a program and we think they can improve our result, so usually not mainly focus on circular but it like in*

	an initiative projects inhabitants in a surrounding area come with ideas to improve and we open to that".
DHT5	*the result of pilots was not successful since there was not specific stakeholder engagement from initiation and it was the case: and the reason was" they did not know it was coming so".*
DHTO4	*it asked from contractor and suppliers to re-use and not throw the material away, and it was as much as possible*
DHO5	*there is communication plan with stakeholders but not specific for circularity or sustainability, its more part of the total process and we do not address it specifically for re-use projects*
SC2	*One plan for participation of stakeholders is sharing the information like facts and figures on the DUBO tool between supplier client and contractor, which in different stages can be also checked and evaluate*

Interviewees code	**Quotations**
	Group: Distinction between levels- Field of culture, communication and behavior Code: Adoptability of organizational culture and structure
DHT1	*the "time pressure" factor is important for this adoptation of structure*
DHT3	*:" a lot of people would like to to implement it if they had the tools*
DHT4	*the "time pressure" factor is important for this adoptation of structure, but it is still doable*
DHTO4	*so they are too much resistance, in terms of projects money andtime, and is not flexible enough*
DHO1	*"people working at municipality are known for flexibility or embracing new things or procedure and of course change is possible but its hard and will take some time and energy; its required some good examplesand cases to do something new* ".
DHO5	*the "time pressure" factor is important for this adoptation of structure* - *it will consume " energy to do and get every one in a new way of thinking*

Interviewees code	**Quotations**
	Group: Distinction between levels- Field of culture, communication and behavior Code: Motivation for re-use
DHT4	*We are not rewarded for this kind of things and project mnager is mostly rewarded for finishing project in time and for the budget*
DHTO2	*I think people working on projects need to have clear motivation and it can be internal motivation like we think this should happen so we trying to make it happen, now it's just a gap of unknowing for people and not feeling responsible for do not do what they used to do*
DHTO5	*At the moment there is no incentive, to think about re-use and impliment it, the incentive is not coming from the from our internal clien ; it's not one of the requirements*

Interviewees code	**Quotations**
	Group: Distinction between levels- Field of Technics and technologies for re-use, technical feasibility Code: Implementation of ambition webs in operational level

DHO1	*the ambition web has been used in the pilot on circularity and we have a lot of targets there but from the ambition web did not really follow a lot of circulation target but more sustainability like ecologic thing and targets that we for ambition web was that we re-use the products, the natural stone and everything that we do with ambition web"*
DHO2	*we see what are the ambition is and then we get this kind of web page and there are always high ambitions but it should be more of a realistic, so there is about 8 or 10 subject on scan so that is very hard to do all ambitions in the project so I think you should be focus on the things that you can really make difference with* - *that web would be 5 levels so then you have more room to choose from because 3 is like know a little but everything*
DHO3	*there's always the question.* *What can we do in the projects and then we try to make it happen and sometimes it works and sometimes not".*

Interviewees code	**Quotations**
	Group: Distinction between levels- Field of Financial aspects and supports Code: High cost of circular projects, circular and re-usable material transactions and existing budget to buy new materials
DHT3	*the price and cost of project can be recognized as a gap in these projects*
DHT4	*In certain cases it might be even more costly than the traditional approach, since includes the specific costs for re-use like costs of storage, transactions and transportations*
DHT6	*The money is not more important in these projects but can play quite a big role* *- You need to choose between circular things and chip things and see what fits".*
DHTO2	*These projects are difficult and expensive*
DHTO3	*have the culture to be aware of the financial aspects*
DHO4	*"enough money is less reason for using old materials, if you have less money you have to go using older materials if you have enough money you say ok there is enough budget to use new materials*
SC1	*"the low contract costs in the projects are also important factors"*

Interviewees code	**Quotations**
	Group: Distinction between levels- Field of Re-use support practices and requirements Code: Too much theories in tactical level, and not clear re-use specific support provided for the operational level
DHT4	*we we are very good in theoretically and making policy statements, but then bringing putting them into practice is not always easy* - *it's easy to have ambitions and you'll need these procedures to to make them work really, so required more re-use specific support*
DHT6	*Realising the target in practice is a long way*
DHTO2	*I think some people know about the municipal policy translations but its very difficult to really implement them*
DHTO4	*there are lots of supports for re-use and attempts within tactical level but nothing is clear to put it into practice for operational actors*
DHO3	*The only thing is that we do a lot already, but it is not written down or something".*

DHO4	*from the tactical you can write a lot in paper but I think its necessary in real projects that on operational level that they cometogether with each other, which is becoming more now*

Interviewees code	**Quotations**
	Group: Distinction between levels- Field of Technics and technologies for re-use, technical feasibility Code: Technical feasibility of the required re-use tasks from clients
SC1	*There is a high gap in technical feasibility, there are certain demands that the municipality require from contractors, which is not always technically feasible*

Interviewees code	**Quotations**
	Group: Distinction between levels- Field of re-use support practices and requirements Code: Linking the supply and demand/availability of materials
DHT5	in regards to problem with availability of materials" *infra is very tailor maid so re-using the whole is not that logic but elements that maybe we can save the timing problem by think we can reuse elements standardize elements than making it too large".*
DHO2	*the re-used object is better for the environment but not always the best for the project"*, so there might be issues with practicality
DHO4	in technical aspect there might be problems with *"availability quality and price*" of the reclaimed materials in the re-use projects

Interviewees code	**Quotations**
	Group: Distinction between levels- Field of Contracts, manuals & guidelines Code: Compatibility of provided designs at operational level with re-use strategy at tactical level
DHT1	*the compatibility of design with re-use strategies depends on the designer I think so it is no general guidelines, so depends on how much efforts the designer put into it to get it done but it's not a really common way of doing it",*
DHTO2	*there are not any principle integrated I have never heard of the re-use design principles*
DHO1	*there are not any principle integrated I have never heard of the re-use design principles*
DHO4	*sometimes we have project that designers want to use new material with special colors that re-using is not easy*

Interviewees code	**Quotations**
	Group: Distinction between levels- Field of Contracts, manuals & guidelines Code: Compatibility of provided designs at operational level with re-use strategy at tactical level
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DHTO2	*there are not any principle integrated I have never heard of the re-use design principles*

DHO1	*there are not any principle integrated I have never heard of the re-use design principles*
DHO4	*sometimes we have project that designers want to use new material with special colors that re-using is not easy*

Interviewees code	**Quotations**
	Group: organizational culture, communication and behavior Code: Clear targets/ strategy for re-use & Consistent follow up/evaluation procedure on targets
DHT1	*we do a sustainability scan (formulating the GWW ambition web) at the start of every project and then we see if there is a logical goal to made for this project on re-use of materials, and it's not a general goal"* - *"in every project if you do the ambition web we should formulate goals and they should be followed up in the normal procedure of the projects, but it is not there yet*
DHT2	*There is no clear percentage for re-use, but there are attempts there*
DHT3	that:" *there is a high gap in ambition formulation and there is no specific target".* - *"there is no coherent follow up on targets of re-use and evaluations or reflections*"
DHT4	*"there are targets for recycle in recent years to recycle by 80,90 percent, but for re-use we re-use what is re-usable",*
DHT5	*still its not very explicit and ambitious on strategic level but if you do not translate to the operational level never come to the conclusion within 2040 we reach our goal"* - *we also not monitor or report about it*
DHT6	*the only target is the general international goals of sustainability and re-using materials is a very important in that*
DHTO1	"*not aware of the exact vision on tactical level, that would be more clear and there is a high gap of on knowing there"*
DHTO2	*at the beginning of projects, the goals are very high and when you get in the realization the less is happen, So, it's mainly re-use as much as possible and there is no smart target* - *"there is no coherent follow up on targets of re-use and evaluations or reflections*" - *it should be part of the way to formalize the project, if you go to next step there should be questionnaire or something or check up in circularity part*
DHTO3	*it is important to know from the initiation what the municipality want from the project about this topic"*
DHTO4	"*not aware of the exact vision on tactical level, that would be more clear and there is a high gap of on knowing there"* *"there are targets for recycle in recent years to recycle by 80,90 percent, but for re-use we re-use what is re-usable",*
DHO1	*tactical level says as target re-use what you can and in the operational level there are only a few elements like natural stones and sometimes the bricks of the road that be re-used* - *"there is no coherent follow up on targets of re-use and evaluations or reflections*" - *" there is no periodic report on the GWW for evaluation",*
DHO2	"*not aware of the exact vision on tactical level, that would be more clear and there is a high gap of on knowing there"*

	- *we tried to do the evaluation and follow up every stage but it does not happen yet".*
DHO3	"*not aware of the exact vision on tactical level, that would be more clear and there is a high gap of on knowing there"* - *"there is no coherent follow up on targets of re-use and evaluations or reflections*"
DHO4	*"there is no coherent follow up on targets of re-use and evaluations or reflections*"
SC1	*What can be re-use should be re-used and what can be recycled should be recycled* - no strict follow up and conducting evaluation procedure from municipality within different stages of projects
SC2	*What can be re-use should be re-used and what can be recycled should be recycled* *No strict follow up and conducting evaluation procedure from municipality within different stages of projects*

Interviewees code	**Quotations**
	Group: organizational culture, communication and behavior Code: Communication and flow of information within and between two levels
DHT3	*the result of pilots are only shared in a small public, and not from operational to tactical level* *- so mybe we should start sharing more information*
DHT4	*Whats difficault for me is very often we do not have enough information to put in practice"*
DHT5	*do not think we have an orgenze system where we have group of people reporting on those projects to steer commetees and learn and. follow up"*
DHTO1	*This information being really clustered to a few people that are really into re-use projects and really have to know and what we should do* and *It should be triyed to spread the information more throughout organziation and to the right levels".* - in re-use projects there is a high gap within communication and organizational behavior
DHTO4	*"the information is going mouth to mouth and it must be done a little bit more to other departmants perhaps".*
DHTO5	*In re-use projects there is a high gap within communication and organizational behavior* *-"From the client, we invited some persons and the results of a meeting shared, they were reacting on that and, that will be only on the project file, so the communication is mostly also restricted to internal actors and not external"*
DHO1	*we made an evaluation for the field pilot and of course we sent result: evaluation and lessons learnt to an internal client but I do not know if its anywhere else that was I do not think the information went further than our team than internal client*" - in re-use projects there is a high gap within communication and organizational behavior *- there is no specific plan for that and communication with stakeholders" is depends on kind of projects and different kind of neighborhood that project is in and not depends on the ambitions on sustainability or re-use or circularity".*
DHO2	*In IBDH that would be very good role for us to do that link within pilot projects and really evaluate how the goeals are realized and what that we can do better to make a better link with the tactical level and also suggest different way of works from operational point of view".*

SC1	*the communication is there the participation is there, but it's a very lengthy process and very lot of steps go through it so it's hard sometimes"*
SC2	*the flow of information should be between all the actors* - for *communication, when the municipality, bring contractor and supplier together and try to have same goals for the end project I think that is the biggest gap"*

Interviewees code	**Quotations**
	Group: organizational culture, communication and behavior Code: Culture and mindset for re-use
DHT1	*lot of people are in their normal routine so it's not in the people's systems to implement that without any change of the system itself so its take some time to change".*
DHT2	*some cultural and institutional things are holding us a bit back, we all have tendency to have something new than old because we do not know if there are some hidden things we should be aware of and do not know so we feel more comfortable with something new*
DHT6	*the behavior is very hard to change and if governments working for years after years, according some certain procedures, then it can take a while to change them*
DHTO1	*Processes and procedures all are always adaptable, but ohm within a large organization like the municipality is going to be quite hard to change a process that has been common for a couple of years".*
DHTO2	*the culture within the municipality is not very flexible and the change will take long time, since people want to do what they used to do*
DHTO4	*there is high gap in culture of people regarding re-use and it costs a lot of time to get everybody within the municipality to think the same so perhaps not necessary to think the same but to recognize the value of materials outside, and also people push too much to refuse the re-use and not to do it"*
DHO2	*the culture within the municipality is not very flexible and the change will take long time, since people want to do what they used to do*
DHO5	*there is a high gap regarding mindset and organizational culture for re-use*

Interviewees code	Quotations
	Group: Field of re-use knowledge, experiences and expertise Code: Explicit internal or external re-use specific roles
DHT6	:" *They are some roles and colleagues who do this next to their job but not explicit like ambassadors"*
DHTO2	*:" the program of sustainability has a little group of people busy with circularity but still very small*
DHTO3	*I know about existence of a group of people active in the sustainability knowledge team* - *I see innovation managers that they are working within municipality but when we are working within knowledge team I do not get in touch with them*
DHTO4	*"collaboration with external ambassadors costs a lot and there was one a project that a complete organization brought into municipality and all the specialists and they told nothing new"*
DHO1	*there were an enthusiastic innovative manger years ago within IBDH which never replaced* - *it was just one pilot that we collaborated with external ambassadors*
DHO2	:" *They are some roles and colleagues who do this next to their job but not explicit like ambassadors"*

	- that would be really better if you make some people really responsible for it and not combine roles for sustainability
DHO4	*Not familiar with existence of such roles*

Interviewees code	Quotations
	Group: Category of contracts, manuals and guidelines Code: compatibility of provided designs at operational level with re-use strategy at tactical level
DHT1	*there is not strict& explicit guideline for re-use*
DHT2	*We are working specially on this theme also from standardization point of view for production and asset management, we as an organization in my opinion not fit yet to be front runner in operational level on that aspect, and in the city we are not focus on this approach, and on the tactical level maybe we are beginning to become aware so its really low level of maturity even there are not much internal policies".*
DHT4	*when it is done like that it it's kind of lucky guess that puts it like that and there is no structural way of implementing these re-use design rules*
DHTO1	*we sometimes set these kinds of criteria that they should consider re-use within the desin*
DHTO4	*It is not only necessary to make a design detachable but you have to make a good design which not only lasts for 30 years like in buildings"*
DHTO5	*there is not strict& explicit guideline for re-use*

Interviewees code	Quotations
	Group: Field of re-use knowledge, experiences and expertise Code: Learning from pilots and previous re-use experiences
DHT1	*" We are tyrying to do pilots but they are not much re-use projects or not directly, so its more like we use old asphalts or concreete as foundations"*
DHT2	"*Some assets are not designed to be re-used"*
DHT3	*They are not pilots known in public or to the awsome level, there were just projects that we initiated with re-usable materials".*
DHT5	*"the reason why we do not do re-use is not because the pilot project was not a success because it is and do love to redu It again when we do have a propper situation to do so",*
DHTO1	*Within the sector the transition is still at the beginning*
DHO1	Some *good examples like the re-use viaduct*
DHO3	*We are doing some projects but there should be more*

Interviewees code	Quotations
	Group: Category of contracts, manuals and guidelines Code: Formulation of guidelines and inter-level follow ups on re-use
DHT5	*"The most imporant gap is translating the policy and now really focus on making that". According to the interviewee*
DHTO1	*guideliens* would be required to really make the next step in reuse project". - *reflect on the process of these pilot projects and learn from the things that went well and the things could have been done better"*
DHTO2	*If people feel they have to do tehn they do*".
DHTO4	*It is mostly based on common sense"*

DHO1	*the tactica level says as guideline re-use what you can and in the operational levell tehre are only a few elements that we re-use",*
DHO2	*the first gap for me is lack of a guideline which is needed for the rest actions, and from the guideline you can make the procedures and structures to follow*

Interviewees code	**Quotations**
	Group: Category of contracts, manuals and guidelines Code: Procurement and contract model
DHT1	*some sort of certain criteria might be fomulated*
DHT2	*the pilot of Rcc had problem with structural safety"*
DHT5	*we use basic requirements and we have method requirement they have to ecceeded by the contractor or the bidder and by doing so they get an advantage and value in the tender* *We are open to do RCC, I think it has to do with scope of our work if we have upportunity in future to do that again we would do so but we not specififcally going to look for scope to do it again*
DHTO1	*some sort of certain criteria might be fomulated*
DHTO3	*Sometimes some kinds of integrated models are being used like involving contractors for more years like also maintence of project*
DHTO4	*if you need a knowledge of contractor you have to use that, pelase give that design to the contractor and if he has smarter ideas*
DHO1	*we do the total design and we specifically state to the market what we want and they make a plan and give a price and we choose the contractor with the best price quality aspect* - *together withh the market we can do innovations and municipality can not do alne so we have to find some collaborations"* - *:" the RCC tried once but never being used, and the problem was,* it shuld be done from initiation and design phase and municipality has lots of in house designers *there will be designers without job or they should do their job differently*
DHO4	*Sometimes some kinds of integrated models are being used like involving contractors for more years like also maintence of project*
SC1	*some sort of certain criteria might be fomulated*
SC2	*" municipality do delivary contract so ask us to deliver project for longer period, and they give some specifications about what percentatge to use of recycled materials into products*

Interviewees code	**Quotations**
	Group: Category of Organizational work procedures and structures Code: Fragmented tactical and operational active sections and groups within departments
DHT1	*The most important gap is within the structures and work procedures*
DHT2	*I know the IBDH (DSB)has its own tactical team which is "sustainability knowledge team" and also the urban planning department also have focus groups on these issues and so its really fragmented but we try to connect the people together* - *DSB organziation mentioned as active tactical & operational level since it do contracting design and realization and also have policy departmants*
DHT3	*The most important gap is within the structures and work procedures*
DHT4	The sustainability knwoeldge team itself is spread arround the organziation *"the DBV is more active on tactical level and have supportive role within sustainability knwoledge team*
DHTO1	*The most important gap is within the structures and work procedures*

	"the DBV is more active on tactical level and have supportive role within sustainability knwoledge team
DHTO2	*The most important gap is within the structures and work procedures*
DHTO3	*DSB organziation mentioned as active tactical & operational level since it do contracting design and realization and also have policy departmants*
DHTO4	*in every team we discuss reuse things, like in IBDH there is a small group discussing re-use and recycling but its in general fragmanted"*
DHTO5	*The most important gap is within the structures and work procedures* - *IBDH is active" on the borderline" and carry both tactical & operational activities*
DHO1	*DPZ is active on very operational level and in contact with inhabitants working on sustainability parts".*
DHO2	*tehre are some active colleagues on re-use of materials from the DSO*

Interviewees code	**Quotations**
	Group: Category of Organizational work procedures and structures Code: Lack of specific work procedure for re-use
DHT4	*It is not done in a really coherent way*
DHT5	*"There is some sort of work procedures for these projects for making the assets re-usable and design them for re-use from the beginning: "the building value model", - the asset management department and the hand book of public space"*
DHO3	*There is no guidelines or something for these projects yet, and it's in normal practice for years now*
SC2	*these projects are still being done like in the traditional form of projects"* - "*MKI indicator" is also some sort of specific stage within the work procedures in these projects*

Interviewees code	**Quotations**
	Group: Category of re-use support practices and requirements Code: Linking the supply and demand/availability of materials
DHT2	*not only storage you need administration to make some sort of exchange like creating a showroom where you can bring your materials, and catalogue it and say we have so many meters of this material with this quality and there should be a data base so others should know what materials we have*".
DHTO4	*In Den Haag it's not easy to drive the truck, store and bring it again to the location when its re-used and sometimes it's easier to put it in truck and dump it somewhere"*
DHO4	*We have no space to store those things we need big open storage for a lot of material exist in the street to store them up for ling time".*

Appendix C.3. List of ranked enablers and barriers based on interviewees responses

Table C.3.a. List of ranked barriers

levels	Number	Barriers	Ranks (1.Not important, 2. somewhat important. 3. quite important 4. very important)																		
			Interviewees on tactical level						Interviewees on operational level										Mode	Median	Rank based on Mode & Median
Tactical	1	Lack of re-use knowledge	4	4	4	2	4	4											4	_	4
	2	Lack of knowledge on positive (environemntal)consequesnces of implimenting re-use strategy	1	4	2	3	2	3											2&3	2.5	2.5
	3	Lack of clear distinction among recycling & re-use activities	1	3	2	2	3	3											3	_	3
	4	Existing priorities other than re-use: other sustainability targets, etc.	3	4	3	2	2	3											3	_	3
	5	Lack of clearly formulated re-use targets and strategies	3	2	4	3	3	3											3	_	3
	6	Using contract types and procurement procedures with low flexibilities	4	1	3	3	2	2											2&3	2.5	2.5
	7	Lack of strict, consistent and explicit re-use guidelines	3	2	4	3	4	3											3	_	3
	8	Lack of specific internal imposing and supporting procedures for re-use	2	4	4	4	2	2											4	_	4
	9	Current internal strict policies, regulations and complex, iterative administrative works for projects	3	3	3	2	3	3											3	_	3
	10	Guarantee and warrantee problems with reclaimed materials	4	2	3	3	4	2											3	_	3
	11	Use of linear and incoherent (economy) business models, for long duration	_	4	3	1	3	4											3&4	3.5	3.5
	12	Lack of required technical documents for re-use; material inventories, technical guidelines.	4	3	2	3	3	2											3	_	3
	13	Low amount of available data on used and recliemd material (quantity and quality, availability,etc)	3	2	3	2	2	2											2	_	2
	14	Lack of standards on cossts of recliemd and re-used materials	2	2	2	_	3	2											2	_	2
	15	ack of consistent storage system for reclaimed materials (transportation, storage, adjustment and material test facilitie	4	4	4	3	3	2											4	_	4
	16	Restricted budget and funds	2	1	3	1	2	3											2	_	2
	17	High level of financial risk of re-use for client and contract	2	2	3	2	2	3											2	_	2
	18	Low financial motivations for implementing extra efforts on re-use for internal and external actors	3	4	4	1	2	3											3&4	3.5	3.5
Tactical & Operational	19	Lack of re-use specialists and lack of required skills/experties in re-use field	4	4	3	3	_	_	3	3	4	4	4	4	2	3	2	4	4	_	4
	20	Actor's change resistance	2	2	2	4	_	_	3	3	2	4	2	4	3	4	2	2	2	_	2
	21	Risk aversion attitude	2	2	2	4	_	_	4	2	4	4	3	4	3	4	1	2	4	_	4
	22	Concerns regarding the re-sell of the recliemd material and material ownership	2	2	3	2	_	_	1	2	1	2	2	3	4	2	2	3	2	_	2
	23	Low integration and conduction of transition procedure from designers	4	3	4	3	_	_	_	3	1	4	_	2	3	3	2	2	3&4	3.5	3.5
	24	Inadequate in-house resources and capacity for renovation of business model	_	_	4	4	_	_	2	2	3	4	2	2	3	_	3	3	2&3	2.5	2.5
	25	D projects on Developing required new technologies for: conducting reclemation audits, evaluating componant's streng	3	_	3	3	_	_	3	2	4	2	2	2	2	_	3	3	3	_	3
	26	Mismatch between the current DFD tools and BIM models	3	_	_	2	_	_	1	2	1	2	2	_	1	_	3	_	2	_	2
Operational	27	Low number of (successful) pilots/project experiences							4	3	3	1	3	2	3	4	4	4	3	_	3
	28	Lack of motivations For re-use & waste management							4	3	1	4	_	2	2	3	2	2	2	_	2
	29	ward re-used components and design methods (DFD) :Hesitates regarding the quality, aesthetic value, and durability o							4	3	4	4	4	2	2	2	3	3	4	_	4
	30	Complicatedness and high number of required transactions and interactions for re-use							_	3	2	4	4	2	3	1	3	3	3	_	3
	31	Lack of compatible collaborative procedures/ approach, and methods							4	3	3	4	2	3	2	3	3	3	3	_	3
	32	Lack of consistent communications and transparency among actors/actors and stakehorlders							2	2	1	3	2	3	2	3	3	3	2&3	2.5	2.5
	33	Lack of roles with responsibilities on drafting, documenting and certify re-use works							2	2	4	2	2	3	4	2	3	3	2	_	2
	34	Incompatibility between functions and targets of old project (project of reclaimed materials) and new projects							2	3	4	2	2	4	3	3	3	3	3	_	3
	35	ossible material damages under decosnstruction operations/complex design of projects and impossibility of diassembly							1	2	4	2	1	2	2	1	2	2	2	_	2
	36	Existing material life spans and need for materials with high EOL (long life span)							2	4	4	2	4	2	4	1	2	2	3	_	3
	37	Technical challenges in adjustment of detached mateerials							2	3	4	2	3	2	2	2	3	3	2	_	2
	38	se in the market, and fragmentation between them: Low number of demolition projects with re-usable elements, and lo							4	2	4	4	1	2	2	3	3	3	3	_	3
	39	Lack of early stage cost and time planning for re-use							3	1	1	4	3	4	3	2	3	3	3	_	3
	40	nal costs of re-use than costs of raw materials; costs of interactions, marketing, maret cost of extra project stages in pi							3	4	2	2	3	1	3	1	2	2	2	_	2

Table C.3.b. List of ranked enablers

levels	Number	Enablers	Ranks (1.Not important, 2. somewhat important. 3. quite important 4. very important)																		
			Interviewees on Tactical level						Interviewees on Operational level										Mode	Median	Rank based on Mode & Median
Tactical	1	Holding Mandatory traimings for CE strategies implimentation	3	4	3	3	2	2											3	_	3
	2	Clarifying Enviromental effects of recycling and re-use	2	3	2	2	3	3											2&3	2.5	2.5
	3	Formulating detailed re-use guidelines for each departmant /role:transport guideline,designguideline,etc	2	2	4	3	2	3											2	_	2
	4	Providing data bases for reclaimable materials in the area	4	4	3	4	3	2											4	_	4
	5	Preparing the context & motivating for cultural/behavioral change & adoptability	2	2	3	3	3	2											2&3	2.5	2.5
	6	Developing leadership style for re-use	2	4	4	3	2	2											2	_	2
	7	Defining ambitious targets &plans for re-use of salvaged materials/reclaimed materials	3	2	4	2	3	3											3	_	3
	8	Formulating warranties for the safety and quality of reclaimed materials	4	3	4	3	4	3											3&4	3.5	3.5
	9	Creating roles with responsibilities on drafting, documenting and certify re-use works/steering the transition	3	4	3	2	3	3											3	_	3
	10	Formulating specific design guidelines and principle for re-use: DFD,etc.	3	2	4	3	3	2											3	_	3
	11	Impose re-use responsible forces on operational actors	2	3	4	3	3	3											3	_	3
	12	Formulating sustainable procurement guidelines with specific re-use considerations, selection and award criteria	2	4	2	3	3	2											2&3	2.5	2.5
	13	Creating capacities for innovation developemnt within the organziation	3	2	3	1	2	4											2&3	2.5	2.5
	14	Formulating innovative work procedures compatible with re-use targets, circular	3	3	3	2	3	2											3	_	3
	15	Developemnt of new tools for collaborations and information flows	2	1	3	2	1	3											2	_	2
	16	Collaborating "with existing salvaged yards" and innovative companies created for reclaimed materials	3	4	3	3	3	2											3	_	3
	17	Proving consistent advices and supportive services to operational actors in re-use projects	2	3	3	3	2	2											2&3	2.5	2.5
	18	cial stimulates for internal and external collaborators with re-use targets like CE R&Ds, Current storage facilities, digot	3	2	3	2	2	4											2	_	2
	19	Existing lower costs of purchasing reclaimed materials than virgin materials.	3	_	3	2	3	4											3	_	3
Tactical & Operational	20	neral Knowledge on circularity & Keen to learn more about that from actors in tactical and operational levels of the or	3	4	3	2	3	2	2	_	4	4	3	3	4	4	4	2	4	_	4
	21	Sharing re-use knowledge with stakeholders (contractors, suppliers, etc.)	4	_	3	3	3	3	3	4	4	4	4	3	3	3	2	3	3	_	3
	22	Positive attitudes towards result of circular projects and being Open to change	3	2	4	4	3	3	4	4	4	4	4	4	3	4	4	2	4	_	4
	23	nindset within organization by creating "sense of urgency" and clarifying financial advantages and values of circular ar	4	3	3	2	3	4	4	3	4	4	4	4	4	4	4	2	4	_	4
	24	Digitalizing CDW management (storage and process of materials for re-use): use of machine learning, etc.	3	4	_	3	3	3	2	3	1	3	2	3	3	1	4	2	3	_	3
	25	Providing more re-use ICT supports,BIM,DFD,..	4	4	3	2	2	2	2	1	2	2	2	3	2	1	2	3	2	_	2
	26	innovation in re-use field in R&D Units: Technologies to track material's litecycle, quality and safety assessment of re	4	4	3	4	3	2	2	2	1	4	2	2	2	4	4	2	2	_	2
	27	Use and cooperate with current inventories, data bases and salvaged yards in the market	3	4	3	3	3	2	3	3	4	3	3	3	3	1	4	3	3	_	3
Operational	28	f deconstruction & demolition to release intact materials for re-use, circular project management, design for circularity,							3	_	4	4	4	4	2	4	2	3	4	_	4
	29	Pilot projects/ positive previous re-use project experiences							3	3	4	4	4	4	4	4	4	3	4	_	4
	30	Consulting with CE consultants and re-use experts in different stages: design procedure, etc.							3	2	1	3	2	4	3	3	4	2	3	_	3
	31	High quality and consistent collaborating among involved actors							_	2	2	4	4	4	2	2	2	3	2	_	2
	32	Formulating and implimenting significant participation and communication plan between stakeholders							_	2	2	4	2	4	3	3	3	2	2	_	2
	33	Implementing innovative procurement models, public/private partnerships & integrated project delivery methods							1	3	3	3	1	3	3	2	1	3	3	_	3
	34	Emphasizing more on re-use in Planning stage of project							4	4	4	4	4	4	2	1	4	4	4	_	4
	35	Adding LCA in design procedures and decision makings for re-use							_	2	2	4	2	4	3	4	3	4	4	_	4
	36	Try to match the supply and demand side of reclaimed material's within the market							4	4	4	4	4	4	4	2	4	3	4	_	4
	37	Providing Regular system for transport and storage of reclaimed materials							4	3	4	4	4	4	2	1	4	3	4	_	4
	38	Asking for support and intervention from external experts and re-use assistants							3	2	2	4	2	4	1	4	1	3	3	_	3

Appendix C.4. Enablers and barriers gathered from interviews

Table C.4. b. List of barriers retrieved from interviews; retrieved from Atlas.ti

Barriers	Totals
○ Operational barrier- existence of chemicals on the reclaimed materials	1
○ Operational Barrier-Extensive time & lack of early stage time planning	4
○ Operational Barrier-Lack of a consistent in house storage place/system (adjustment, transportation, storage) for reclaimed materials	3
○ Operational barrier-lack of active stakeholder engagement	1
○ operational barrier-lack of knowledge of how to start with re-use	2
○ operational barrier-low number of demolition project with re-usable elements, incompatibility between functions and targets of reclaimed materials and new projects/ and low demand for circular projects	1
○ Operational barrier-risk averse attitude and resistance to change from contractors, internal actors and stakeholders side)	8
○ Operational barriers- conflicting work procedures with other sustainability targets	2
○ Tactical & operational barrier- Guarantee and warrantee problems	3
○ Tactical & operational Barrier- Lack of re-use mindset	2
○ Tactical & Operational barrier- required high quality materials, certain specifications and high technical standards for maintenance	3
○ Tactical & operational barrier-Lack of compatible collaborative procedures / Existence of traditional method and approach; Single contracts & Cost driven tenders	2
○ Tactical & operational barrier-lack of knowledge on possibilities for re-use	2
○ Tactical & Operational barrier-Negative attitudes & cultural resistance towards re-used components and design methods like DFD , hesitates regarding quality and durability	2
○ Tactical & Operational barriers- High extra costs; transportation, transactions and storage	4
○ Tactical barrier- Current internal restricting rules within manuals like handbook of public places to work with reclaimed materials and complex iterative administrative works for projects	3
○ tactical barrier- Lack of knowledge of market situation/development	1
○ Tactical barrier-Complicatedness and required high number of interactions	3
○ Tactical barrier-Lack of clearly formulated re-use targets and strategies	3
○ Tactical barrier-lack of guides for design for re-usability from top levels	1
○ Tactical barrier-very fragmented tactical arena and network , cannot find each other	1
○ Tactical barriers- Busy roads and traffic problems	1

Table C.4. a. List of enablers retrieved from interviews; retrieved from Atlas.ti

Enablers	Total
○ Operational enabler- bow ward model from concrete agreement to check re-use feasibility and design for re-usability	1
○ Operational enabler- current sense of urgency for re-use in young generation	2
○ Operational enabler- Dub tool as indirect communication tool for sharing information on contract	1
○ Operational enabler- Existing expertise and potential to train	2
○ Operational enabler-changing the mindset and accept difficulties and short-term costs	1
○ Operational Enabler-creating financial motivations	2
○ Operational enabler-Informing from the whole assets management vision from the initiation phase	1
○ Operational Enabler-putting circularity criteria in the tenders	2
○ Operational enabler-Using high knowledge on contractor side in re-use	2
○ Operational enablers-Some people with circularity mindset/ sustainability teams and focusing further project's scope	5
○ Tactical & operational enabler- Existing advisory roles on re-use projects within the procurement department	1
○ Tactical & operational enabler- Existing efforts within the municipality to make cultural changes	1
○ Tactical & operational enabler- existing knowledge exchange platform on sustainability "sustainability dialogue"	1
○ Tactical & operational enabler- experience with RCC method from the pilot project	1
○ Tactical & operational enabler-apply the existing handbook of public places as guideline in operational level and consistent revision of that	2
Tactical & operational enabler- Providing regular (inhouse) storage system with digital CDW management and data bases and explore opportunities in the area	5
○ Tactical & operational enabler- Formulating specific design guidelines and principles and implimenting them	3
○ Tactical & Operational enabler-Lessons learnt from counterpart organizations	2
○ Tactical & operational enabler- Existing general "sustainability knowledge team" and internal advisors active on re-use	4
○ Tactical & operational enabler- Existing Intra- sustainability program communications	1
○ Tactical & operational enabler-use of reclaimed components from other public organizations in design	2
○ Tactical enabler- existing Certain rules and work procedures to work with materials	1
○ Tactical enabler- Existing manual of some material specification to implement re-use	2
○ Tactical enabler- existing regulations for recalculating and extending lifetime	1
○ Tactical enabler- Existing sustainability target formulation framework (GWW)	7

○ Tactical enabler-dedicating extra budgets	3
○ Tactical enabler-Existing scarcity and High cost of virgin materials	2
○ Tactical enabler-find each other on tactical level	1
○ Tactical Enabler-increasing the stakeholders awareness on possibilities for re-use	1
○ Tactical enabler-Obligation to re-use from internal client side	2
○ Tactical Enabler-Re-use should be done within programs to enhance learning process	2
○ Tactical enablers-creation of more rooms and liberties within internal manuals, and decrease the bureaucracies	2
○ Tactical enablers-Existing attention from public clients to sustainability and agreements & documents and forcing to implementing sustainability scan	7
○ Tactical enablers-Urgency of other targets, like maintenance of bike lines	1
○ Tactical & operational enabler- spread knowledge and experiences to the other level & more communication efforsts	2
○ Tactical enabler- Existing Specific framework for re-use :MKI calculation	1

Appendix C.5. Quotations relevant to the theme enablers and barriers of interviews

Interviewees code	Quotations	Enabler
DHT1	*within the policies there is a specific attention towards re-use of materials*	***Existng attention from publivc clients to sustainbility and agrements & documents and forsing to implimenting sustainability scan***
DHT2	"*We do trust on the people on the operational to do their job really good".*	***Existing expertise and potential to train***
	If we only focus in one project we say, our project is lost, and in program we say we can handle it and let try something elese for the next so if you put it in the program it's a better atmosphere for you to create the right conditions for improvements because you have a hundred project to come and you want to make it better every time and that's I think tahts a big enabeler - "*we have a program organization where we have same people doing all our bridges and all our quey wall and what they learn from one can use for the next*	***Testing/implimenting re-use within programs to inhance learning process***
	we have our own department working on this digital twin, we have our own engineering department working with BIM for the design part and we have our own maintenance department which should work with outcome of both so we have 3 elements within same organization make it possible if we can find each other and work to gether, so if we pick a right connection it can be enabler for re-use projects".	***Make the network of re-use more clear***
DHT3	*The internal client/commisioner, should determine if you in the projects are obliged to re-use materials"*	***Obligation to re-use from internal client side***
DHT4	*we need some people who who feel more liberty to do things just in the way that they think. we are overly regulated in this municipality we are quite a bureaucratic country*	***creation of more rooms and liberties withininternal manuals, and decrease bureaucracies***
	we should look for good examples in operational level, highlight them and spend more communication efforts into them so these would be really on the tactical level to provide information and think on that	***spread knowledge and experiences to the other level & more communication efforsts***

	- *after finding good examples and highlight them from operational level, on the tactical level, we need people who can spread the word to put like that and to provide information and things like that*	
DHT5	*If we do not have it we will come up with it, and I have strong confidence in all technical people and from practical side to academic"*	***Existing expertise and potential to train***
	design could be enabler if they start rethink to design with re-using in mind like design for re-use".	***Formulating specific design guidelines and principles and implimenting them***
	If we really want to get lift up with these kinds of developments we should do much more into continuity into programs"	***Testing/implimenting re-use within programs to inhance learning process***
	there is political commitment which is extremely relevant	***Existng attention from publivc clients to sustainbility and agrements & documents and forsing to implimenting sustainability scan***
DHT6	*the municipality as public client organziation have responsibility with public money and want to do the best"*	***Existng attention from publivc clients to sustainbility and agrements & documents and forsing to implimenting sustainability scan***
DHTO1	*there are certain budgets or subsidies that enable these projects and it's also within our policies to do so"*	***Existng attention from publivc clients to sustainbility and agrements & documents and forsing to implimenting sustainability scan***
DHTO2	*mayor and alderman/city council , decide it there should be more thinking about environement in project or in general"*	***Existng attention from publivc clients to sustainbility and agrements & documents and forsing to implimenting sustainability scan***
DHTO3	*we do not have to do it on our own".*	***Using high knowledge on contractor side in re-use***
	in the policy there should be more room for using products	***creation of more rooms and liberties withininternal manuals, and decrease bureaucracies***
	"it is important that you can oversea what the impact is when we do not make designs compatible for re-use materials".	***Formulating specific design guidelines and principles and implimenting them***
	we have some people that make the difference, who try to develop or support these kinds of projects	- ***Some people with circularity mindset/ sustainability teams and focusing on further project's scope***

	"you need organziations that has embraced the topic of re-use and there are other parties like other municiplae and other internal comissioenrs that we can learn from them	- ***Leasons learnt from counterpart organizations*** -
DHTO4	*If you say A you must also say B, you have to take the consequences of B you cannot say I want to re-use every think and you see the bill and say no it is too much expensive please use everything new".*	***Developing re-use mindset & creating sense of urgency for re-use***
	Re-use need storage spaces"	***Providing regular (inhouse) storage system with digital CDW management and data bases and explore upportunities in the area***
DHTO5	*they are maybe possibilities for re-use there which are not scanned and we do not know yet*	***Providing regular (inhouse) storage system with digital CDW management and data bases and explore upportunities in the area***
DHO1	there are policy or agreements/documents to think about circularity on tactical level",	***Existng attention from publivc clients to sustainbility and agrements & documents and forsing to implimenting sustainability scan***
DHO2	*right expert judgements in your team in the operational level is important. we do sustainability scan report and we organized it now and there is a group that really make sure that all the projects do the scan and the good thing about it is a group of people that are not in your project so you do not have to pay them but they sort of advice you on that subject and they really help so you do not have to think about that yourself or you do not have to organize that project on that level but its already organized".* *- some people only look their own scope of work and they do not want to go beyond, but you have to build the project not ony for now so you also say what does the project means for the whole city how does it fit in the future so it helps for project, some popele are there to make sure that they are not allowed to only focus on their own project scope but also focus beyond".*	- ***Some people with circularity mindset/ sustainability teams and focusing on further project's scope***
	there is agreement to do sustainability scan within every project so those kinds of things are very appreciated if it's necessary to do so makes makes you then you really have to do it and think about it and give new ideas so I think".	- ***Existng attention from publivc clients to sustainbility and agrements & documents and forsing to implimenting sustainability scan***
	Some public client organziations already have disabling bridges or staff so they have more products that they can re-use and they offer to us and	- ***use of recliamed componants from other public organziations in design***

	usually when you look for something like that its harder, but when somebody has something you can implement that in your design".	
DHO3	*the designers should be more open to re-use and use other materials in the city*	***Formulating specific design guidelines and principles and implimenting them***
DHO5	*"about re-using materials, so then it came from the neighborhood and not form our internal organization so that makes it might be help in thinking about that kind of opportunities*	***Providing regular (inhouse) storage system with digital CDW management and data bases and explore upportunities in the area***
SC1	*we have more knowledge about re-usable themes and how they can be implemented in projects*	***Using high knowledge on contractor side in re-use***
SC2	*there are people who want to use and think about using recycled or secondary goods to re-use or recycle people that have gens to move forward*	- ***Some people with circularity mindset/ sustainability teams and focusing on further project's scope***

Interviewees code	Quotations	Barrier
DHT1	-" *which means you have to have a place to stock it until you use it again and so it's a timing I think or a planning issue or sometimes it needs to be sorted out or cleaned before you can re-use it which makes an extra effort to be made or need transport to place that the street brakes can be cleaned which is not so sustainable".* *-" you have to have a place to stock it until you use it again and so it's a timing I think or a planning issue or sometimes it needs to be sorted out or cleaned before you can re-use it which makes an extra effort to be made*	***Complicatedness and required high number of transactions and interactions***
	" for re-use sometimes material needs to be sorted out or cleaned before you can re-use it which makes an extra effort to be made or need transport to place that the street brakes can be cleaned which is not so sustainable	***Existing priorities other than re-use: other sustainability targets & and conflict of work procedures with other targets***
	" the material that can be re-used and come out of a project do not always match the starting point of the new projects where they can be re-used, which means you have to have a place to stock it until you use it again and so it's a timing I think or a planning issue or sometimes it needs to be sorted out or cleaned before you can re-use it which makes an extra effort	***Extensive time of projects and lack of early stage time planning***

	"there is a lack of nearby facility to clean and prepare for re-use of reclaimed materials, while sometimes the material should be cleaned before you can re-use it".	***Lack of a consistent in house storage place/system (adjustment, transportation, storage) for reclaimed materials***
	one barrier is also specially with the maintenance department because there is always an insecurity if you re-use materials, there will doubt about if they will still good for years and if you re-use materials you do not know.	***Required high quality materials, certain specifications and high technical standards for maintenance***
DHT2	No response	
DHT3	" so where can you get this material from for re-use? and the availability of materials is also a barrier within these projects	***low number of demolition project with re-usable elements, incompatibility between functions and targets of reclaimed***
DHT4	*This manual contains many norms regarding to infrastructure, how it should be constructed, how but material should be used, and things like that, and that's also kind of barrier So it's difficult to rethink and certain types of solutions and for that we miss chances".*	***Current internal restricting rules within manuals like handbook of public places to work with reclaimed materials and complex iterative administrative works***
	If you Really think about circularity, it might cost you a little bit more of time because you Have to rethink things, but there is no time to really think about it in projects, this politician will really want to have fixed the street or have new bridge and things in certain time	***Extensive time of projects and lack of early stage time planning***
DHT5	*:" people want to match the project within the budget that available and it never fits so I think so they are logically risk averse I think an people from design perspectives are much willing to take risks, the designers the contractors or whatever because they are not responsible for management afterwards so that some sort of distribution of risk over the whole chain*	***Risk aversion attitude and resistance to change from all internal and external***
	"much specifically public clients try to tender also another values, sustainability and less nuisancefor inhabitants around that kind of staff but still with very strong cost driver in the tendering process, and the project single contract approach and cost driven approach are different things and barrier is that two things".	***Lack of compatible collaborative procedures / Existence of traditional method and approach; Single contracts & Cost driven tenders***
	if we some up with new solutions for –reusing certain things and it not covered by regulations they basically will rejected because other wise they have to take some sort of risk and the basic issue with asset management	***Current internal restricting rules within manuals like handbook of public places to work with reclaimed materials and complex iterative administrative works f***

	” from design perspective its seems to have preferences for new materials somehow from static reasons or simply we want to have other colors or so	***Required high quality materials, certain specifications and high technical standards for maintenance***
DHT6	No response	
DHTO1	*There is a barrier in the way of thinking*	***Lack of re-use mindset***
DHTO2	*“ these transactions are some times very difficult and expensive*	***Complicatedness and required high number of transactions and interactions***
	:” we want to make very good end result and maybe it will be a bit less if you use re-used materials, money, sometimes its cheaper to use new because you should clean everything and store it somewhere until you can re-use, people think it is difficult, maybe the end result statically is not what they whish for and contractors always prefer to use new	***Risk aversion attitude and resistance to change from all internal and external***
	one barrier is technical standards of re-usable materials, we want to make very good end result and maybe it will be a bit less if you use re-use materials	***Required high quality materials, certain specifications and high technical standards for maintenance***
	mayor and alderman/city council , decide it there should be more thinking about environement in project or in general”	
DHTO3	*we are used to do and we like to do it as it last year because make us confident and we find it very difficult to be out of our comfort zone, but we have to try, if we do that first ten time its not going well I think, maybe after that we have a little bit of learning process*	***Risk aversion attitude and resistance to change from all internal and external***
DHTO4	use of re-us eprinciples like DFD may make the asset vaulnarable and ruin the durability like as mentioend by the interviewee	***Negative attitudes & cultural resistance towards re-used components and design methods like DFD, hesitates regarding quality and durability***
	“time is also an issue if you use more time is more expensive and we have to finish projects in certain time frames	***Extensive time of projects and lack of early stage time planning***
DHTO5	*if you update your initiative, they might like it and promote it and say you are doing a good job but you are more alone and island and so it doesn't make much sense if it's not really implemented and from the client from the municipality so the task is too big if you do it on yourself. The Barrier: It's more that the organization is not really the mindset for that*	***Lack of re-use mindset***
DHO1	*one main barrier is lack of a storage place, like when it comes out from one project the way you can keep it and use it somewhere else*	***Lack of a consistent in house storage place/system (adjustment, transportation, storage) for reclaimed materials***

	we do not have those areas anymore and yea not enough space in the city to store it and to keep it safe, in some projects we could not re-use in same project but in another project we wanted to use like natural stones but there was couple of month between the time that they came out and they could not get in another project	
DHO2	*you always have to make sure who are you making it for and who is going to maintain it, it is very important in every project because in the ned you have to handed over to the asset organization so you have to know who you are building it for but the thing is very hard to get the people that maintain the project you are building for at the table in the design process so it is very hard to get the right people at the right time to specify what they want what they need and also because they do not always know how they going to maintain*	***Complicatedness and required high number of transactions and interactions***
DHO3	*If the policy were more loose, more open, more possibilities, then we could use a lot more products*	***Current internal restricting rules within manuals like handbook of public places to work with reclaimed materials and complex iterative administrative works for projects***
DHO4	*still new materials are easier to use than older materials"*	***Risk aversion attitude and resistance to change from all internal and external***
	"It is hard to work on this extensive time, with the busy and traffic problems in road	***Extensive time of projects and lack of early stage time planning***
SC2	*so old mans and old habbits, its cultura,l mental thing most of the time it does not cost any much more money to re-use materials but they think it's the case for most of the time but its not:* so the mindset is making it difficult.	***Lack of re-use mindset***
	when they are new kinds of material it has to be proven that is sustainable and durable for long tiem but that's kind of things takes 2,3,4 five years to show and prove that you are making new innovative proejcts which is durable and sustainbel	***Negative attitudes & cultural resistance towards re-used components and design methods like DFD, hesitates regarding quality and durability***

Appendix C.6. Explanations on enablers and barriers gathered from interviews

Tactical barriers

Complicatedness and required high number of transactions and interactions

Within re-use projects, the project stages are more complicated and some extra stages should be followed by actors, as mentioned within previous sections. As mentioned by DHT1: reclimed material "*shoud be sorted out or cleaned before you can re-use it which needs extra effort to be made to make that the street bricks can be cleaned".* These extra stages and required high number of transactions, will make a need for more intercations between actors as well, to control these project's and asssure the quality. According to DHTO2: *" these transactions are some times very difficult and expensive",* and also according to DHO2: "*it is very hard to get the right people at the right time to specify what they want what they need, specifically, it is very hard to get the people that maintain the project you are building for at the table in the design process".*

Current internal restricting rules within manuals like handbook of public places to work with reclaimed materials and complex iterative administrative works for projects

Within the Municipality, projects specifications should be constantly checked by the principles and requirements within manual of Handbook of public places (HOR), which is a complex and iterative procedure and have restricting effects on new methods of doing works like re-use. According to the interviewee DHT4:" *This manual contains many norms regarding to infrastructure, how it should be constructed, how material should be used, which sometimes makes it difficult to rethink certain types of solutions and we miss chances for innovation".* According to DHO3*:" If the policy were more open, with more possibilities, then we could use a lot more products".* Also the DHT5 mentioned that: "*if we some up with new solutions for –reusing certain things and it not covered by regulations they basically will be rejected",* which makes the project more complex.

Tactical & operational barriers

Lack of re-use mindset

In implementing innovative approaches like re-use some changes should be occurred within work procedures which needs open minds to implement them. According to DHO1: "*There is a barrier in the way of thinking".* The interviewee DHTO5 mentioned that*" if you update your initiative, they might like it and promote it and say you are doing a good job"* however, since the whole organization does not have the mindset for re-use, the ideas will not take into actions. As mentioned by the interviewee SC2:*" so old mans and old habbits, its cultural/mental thin,g most of the time they think it costs much more money but its not:* so the lack of re-use mindset is making it difficult.

Negative attitudes & cultural resistance towards re-used components and design methods like DFD, hesitates regarding quality and durability

It is assumed by interviewees that durability and quality of reclaimed material is not as much as first hands. According to SC2:"*with that materials, it has to be proven that is sustainable and durable for long time but it takes 2,3,4 five years to show"* Moreover, there is a belife that use of re-us eprinciples like DFD in design may makes the asset vaulnarable, and ruins the durability like as mentioend by the interviewee DHTO4.

Lack of compatible collaborative procedures / Existence of traditional method and approach; Single contracts & Cost driven tenders

The innovative sort of projects with complicated procedures like re-use requires also innovative methods to follow. Currently re-use projects are done with traditional project delivery model and include mostly the cost factor as criteria. According to the interviewee DHT5: *"*much specifically public clients try to tender also another values, like sustainability and less nuisancefor inhabitants around, but still with very strong cost driver in the tendering process". Handing out projects with single contracts in traditional way, using cost driven criteria recognized by interviewees as barriers for implimenting re-use projects.

Operational barriers

Risk aversion attitude and resistance to change from all internal and external parties

According to DHO4:" *still new materials are easier to use than older materials"* which is a concrete belief for most of the actors at operational level, and revealed cultural resistance. According to interviewees like DHTO2 this resistance is due to many factors like high costs of storage and cleaning, difficulties in re-use procedure, willin of contractors for using new materials. People in the municipality find re-use *"very difficult to be out of their comfort zone"* According to DHTO3. According to DHT5 that within municipality*:" people want to match the project within the budget that available and it never fits so I think so they are logically risk averse and designers/contrators are much willing to take risks, because they are not responsible for management afterwards".*

Extensive time of projects and lack of early stage time planning

As mentioned by DHT1:" *the material that can be re-used and come out of a project do not always released at the starting point of the new projects where they can be re-used, or sometimes it needs to be sorted out or cleaned before you can re-use it"*. Hence sometimes there is a timing problem between the two projects, and sometimes the re-use procedure will be timely extensive which needs accurate planning. According to the interviewee DHT4 & DHTO4, more time is needed for implementing circular projects which cannot be fit in the time frame of projects, which consequently will cause more complexities and costs within projects, if does not take into account for planning from early stages. A*lso According to DHO4: "It is hard to work on this extensive time, with the busy and traffic problems in road".*

Existing priorities other than re-use: other sustainability targets & and conflict of work procedures with other targets

Currently within public client organziations like the municipality of Den Haag there is a focus on different sustainbility targets like being energy neutral and producing zero emission. According to the interviewee DHT1: *" for re-use sometimes material needs to be sorted out or cleaned before you can re-use it which makes need for transport to place that the material can be cleaned, which is not so sustainable".* Hence sometimes, conflict between the re-use and other sustaibaility targte might hinder the implimentation of re-use strategy.

low number of demolition project with re-usable elements, incompatibility between functions and targets of reclaimed materials and new projects/ and low demand for circular projects

According to the interviewee DHT3, it is not clear from where the materials can be supplied," *and the availability of materials is also a barrier within re-use projects". This low availability of material for re-use, is either due to low number of demolition projects, or incompatibility between specific actions of reclaimed materials with new projects and new designs. Also, there are low demands for circular projects.*

Lack of a consistent in house storage place/system (adjustment, transportation, storage) for reclaimed materials

According to DHO1:"*one main barrier is lack of a storage place, that we do not have those areas anymore and there is not enough space in the city to store and keep reclaimed material safe, sometimes we could not re-use in same project but in another project, like in a project there was couple of month between the time that they came out and get in another project".* Also, the storage is needed to *"make material clean and prepare"* for re-use, according to DHT1.

Required high quality materials, certain specifications and high technical standards for maintenance

According to DHT1:" *with the maintenance department because there is always an insecurity if you re-use materials, there will be doubt about if they will still good for years".* "So the durability of available material for re-use should also be considered, which make it hard to find proper re-usable material. Also, according to DHT5 sometimes the material should have some specifications*:" from design perspective its seems there is preferences for new materials, from static reasons or simply we want to have other colors or so".*

Other than these barriers, the barriers which identified as high ranked and most important ones gathered from the survey are also added as potential barriers to deal with the top 10 fields of gap. The identified enablers and barriers relevant to the top 10 field of gaps which are potential to deal with them, are listed and linked to the gaps in the next section as conclusion of chapter.

Tactical Enablers

Make the network of re-use more clear

Since the organziational structure regarding implimentation of re-use ise very fragmanted within the municipality, making more coherent network between them can be beneficial for implimenting re-use projects. Like as the interviewee DHT2 said: "*if we can find each other and work together, and if we pick a right connection it can be enabler for re-use projects".*

Obligation to re-use from internal client side

The role of internal commissioners are crucial in re-use projects as well, since normally the internal commissioner has the role of providing project's requieements to the team and check that regualrely, and re-use can be defined as a specific requirement for projects. According to the interviewee DHT3: *" The internal commisioner, should determine if you in the projects are obliged to re-use materials".* Hence the internal commissioner can also act as an enabler for re-use.

Testing/implimenting re-use within programs to inhance learning process

Based on experiences gained by practitioners within re-use projects, running high number of re-use projects simultaneously and in format of program can be beneficial. Like mentioned by the interviewee DHT5: *"If we really want to get lift up with these kinds of developments we should do much more into continuity into programs"* . Also its mentioned by the interviewee DHT2 that: "*the program is a better atmosphere for you to create the right conditions for improvements because you have a hundred project to come and you want to make it better every time".*According to DHT2 that: "*we have a program organization where we have same people doing all our bridges and all our quey wall and what they learn from one can use for the nex",* which can be an enabler for re-use. It is just require to forcuse on re-use in these projects.

Creation of more rooms and liberties withininternal manuals, and decrease bureaucracies

Innovative procedures like re-use require some more flexibilities, room for moneouvre, less organziational complicatedness and rough regualrities to be implemented. According to DHO3: "*in the policy there should be more room for using recliemd products".* Also, according to the DHT4: *"we need some people who feel more liberty to do things just in the way that they think. we are overly regulated in this municipality we are quite a bureaucratic country".* Creating more room and liberties within manuals, can be helpful for implimenting re-use.

Existng attention from publivc clients to sustainbility and agrements & documents and forsing to implimenting sustainability scan

According to the interviewee DHT6: "*the municipality as public client organziation have responsibility with public money and want to do the best"*, henec this respinisibility is currently acting as catelizer for implimenting re-use projects within municiplaity. According to the interviewee DHO2: *"there is agreement to do sustainability scan within every project so those kinds of things are very appreciated if it's necessary to do so, then you really have to do it and think about it and give new ideas".* The interviewee DHTO2 said in this regard*: "mayor and alderman/city council , decide it there should be more thinking about environement in project or in general"*, So the upper levels within the municiaplity desire to implement more of these projects as public client's representatives. The municipality have some sort of comitment and attention towards sustainability and the re-use strategy is very appriciated to be done as underneath of sustainability regularities in this public client organziation.

Obligation to re-use from internal client side

The role of internal commissioners are crucial in re-use projects as well, since normally the internal commissioner has the role of providing project's requieements to the team and check that regualrely, and re-use can be defined as a specific requirement for projects. According to the interviewee DHT3: *" The internal commisioner, should determine if you in the projects are obliged to re-use materials".* Hence the internal commissioner can also act as an enabler for re-use.

Tactical & operational Enablers

Providing regular (inhouse) storage system with digital CDW management and data bases and explore upportunities in the area

According to DHTO4: *"Re-use need storage spaces"* which is a very strong enbaler for re-use, since in that all these necessary stages of cleaning, adjusting of shapes and storage itself, can be done. For re-use projects having access to the reclaimed materials is highly important. For exploring the available materials, other than the materials within previous internal projects which can be re-use, there is also another option. In this regard interviewee DHTO5 mentioned; *"they are maybe possibilities for re-use there, which are not scanned and we do not know yet".* Hence it is useful to also looking for upportunities in the neighborhood as mentioned by DHO5.

Formulating specific design guidelines and principles and implimenting them

Design for re-usability and implementing of principles relevang to them within project's design stages, also mentioned within the literatures several times as important enabler for re-use. As it is mentioned by the interviewee DHTO3: *"it is important that you can oversea what the impact is when we do not make designs compatible for re-use materials".* Moreover, according to the intevrieww DHT5:" *design could be enabler if they start rethink to design with re-using in mind like design for re-use*". How ever apparently this it not the case currenytly and *"the designers should be more open to re-use and use other materials in the city":* mentioned by DHO3.

Leasons learnt from counterpart organizations

They are some other public organziations like other municiplaities who are front runners in re-use and already implement some protetype eprojects with completely with re-use method. As mentioned by the interviewee DHTO3: *"you need organziations that has embraced the topic of re-use and there are other parties like other municiplae and other internal comissioenrs that we can learn from them".* Learning from experiences of these organziations can act as anotehr enabler.

spread knowledge and experiences to the other level & more communication efforsts

According to DHT4: **"***we should look for good examples in operational level, highlight them and spend more communication efforts into them so these would be really transferred to the tactical level to provide information and think on that".* Hence one other enbaler is consistant and active communications on re-use projects between tactical level and internal/external parts of operational level, to be able to learn required information for commissioning next projects. The interviewee DHT4 mentioned: **"** *after highlighting good examples at operational level, on the tactical level; we need people who can spread the word and provide information like that".* Hence the gathered information in each level should be spread by both levels arround the organziation to extract required benefits from experiences.

Use of recliamed componants from other public organziations in design

The required recliamed materials can be also provided by other public organziation as mentioned by the DHO2: "*Some public client organziations already have disabling bridges or staff that they can re-use and they offer to us and usually, when you look for something like that its harder, but when somebody has something, you can implement that".* Hence using this upportunities and asking for such componants can be beneficial in conducting re-use projects, since the reclimed materials are already there and the only stages which should be followed will be storing the materials,doing a little adjustments & transporting them to the project site. The time consuming and costly stages of conducting reclaimation audits and detaching the materials, will be skiped.

Existing priorities other than re-use: other sustainability targets & and conflict of work procedures with other targets

Currently within public client organziations like the municipality of Den Haag there is a focus on different sustainbility targets like being energy neutral and producing zero emission. According to the interviewee DHT1: *" for re-use sometimes material needs to be sorted out or cleaned before you can re-use it which makes need for transport to place that the material can be cleaned, which is not so sustainable".* Hence sometimes, conflict between the re-use and other sustaibaility targte might hinder the implimentation of re-use strategy.

Lack of compatible collaborative procedures / Existence of traditional method and approach; Single contracts & Cost driven tenders

The innovative sort of projects with complicated procedures like re-use requires also innovative methods to follow. Currently re-use projects are done with traditional project delivery model and include mostly the cost factor as criteria. According to the interviewee DHT5: *"*much specifically public clients try to tender also another values, like sustainability and less nuisancefor inhabitants around, but still with very strong cost driver in the tendering process". Handing out projects with single contracts in traditional way, using cost driven criteria recognized by interviewees as barriers for implimenting re-use projects.

Complicatedness and required high number of transactions and interactions

Within re-use projects, the project stages are more complicated and some extra stages should be followed by actors, as mentioned within previous sections. As mentioned by DHT1: reclimed material "*shoud be sorted out or cleaned before you can re-use it which needs extra effort to be made to make that the street bricks can be cleaned".* These extra stages and required high number of transactions, will make a need for more intercations between actors as well, to control these project's and asssure the quality. According to DHTO2: *" these transactions are some times very*

difficult and expensive", and also according to DHO2: "*it is very hard to get the right people at the right time to specify what they want what they need, specifically, it is very hard to get the people that maintain the project you are building for at the table in the design process".*

Spread knowledge and experiences to the other level & more communication efforsts

According to DHT4: **"***we should look for good examples in operational level, highlight them and spend more communication efforts into them so these would be really transferred to the tactical level to provide information and think on that".* Hence one other enbaler is consistant and active communications on re-use projects between tactical level and internal/external parts of operational level, to be able to learn required information for commissioning next projects. The interviewee DHT4 mentioned: **"** *after highlighting good examples at operational level, on the tactical level; we need people who can spread the word and provide information like that".* Hence the gathered information in each level should be spread by both levels arround the organziation to extract required benefits from experiences.

Operational Enablers

Existing expertise and potential to train

To literally implement re-use circularity strategy in infrastructure sector, specific expertise is required. Without this expertise the implementation of re-use strategy at operational level is impossible. It is believed by interviewees like DHT5 & DHT2 that the people within operational level have enough technical potentials to gain this expertise in short time and conduct such projects. The interviewee DHT5mentioned that; "*If we do not have it we will come up with it, and I have strong confidence in all technical people and from practical side to academic".*

Developing re-use mindset & creating sense of urgency for re-use

They are for sure some complicatedness and extra costs like costs of transportation within the re-use projects. However, considering the high environmental advantages in these projects changing the negative mindset and accepting difficulties is beneficial. According to DHTO4, *"If you say A you must also say B, you have to take the consequences of B you cannot say I want to re-use every think and you see the bill and say no it is too much expensive please use everything new".*

Using high knowledge on contractor side in re-use

In implementing some innovative and circular strategies like re-use, there is more knowledge and more developed technologies and innovative methods in hands of market parties than clients. As the interviewee SC1 who is representative of a contractor party mentioned; *"we have more knowledge about re-usable themes and how they can be implemented in projects".* Also the interviewee DHTO3 said; *we do not have to do it on our own".*

Some people with circularity mindset/ sustainability teams and focusing on further project's scope

Although there might be some resistance in terms of re-use, there are also some people within the municipality organization who have green heart for sustainability. Also the interviewee DHTO3 mentioned; *"we have some people that make the difference, who try to develop or support these kinds of projects".* Within projects, as interviewee DHO2 said*; "some people only look their own scope of work and they do not want to go beyond, but you have to build the project not only for now but for the future, some popele are there to make sure that they are not allowed to only focus on the project scope but also focus beyond".* The 'sustainability knowledge team' is known by interviewees as example of people with circularity mindset who are more focused on topics further projects scope, on sustainability and circularity targets like re-use.

Appendix D. Framework Development & Expert evaluation

Appendix D.1. Questions of expert evaluation session

The three questions asked from experts in the expert evaluation session are as follows:

1. Do you agree with the recommended procedures within this framework for closing the identified gaps?
2. Do you think the framework is applicable within the organization to implement more re-use projects in the future, considering:
   - The assigned organizational level?
   - Short-term, long-term target?
3. What are your recommendations to improve the framework and make it more beneficial for the municipality to link the tactical and operational level and implement more re-use projects?

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