A PROCESS FRAMEWORK FOR THE TRANSITION TO CIRCULAR URBAN AREA DEVELOPMENT OF M4H

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A PROCESS FRAMEWORK FOR THE TRANSITION TO CIRCULAR URBAN AREA DEVELOPMENT OF M4H

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Rotterdam, December 2019

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PREFACE

Presented before you lies the research report “A process strategy for the transition to circular urban area development”. This report investigates the topic of circularity in the built environment and the process strategy needed for the transition to circular urban area development.

This research is a part of my final assessment for the master Construction Management and Engineering (CME) at the Faculty Civil Engineering of the Delft University of Technology and is written on behalf of the internship at the Port of Rotterdam (PoR) Authority. This research has been conducted under the supervision of Prof.dr.ir. Hans Bakker, Dr.ir. Els Leclercq, Dr.ir. Jaco Quist and Ir. Isabelle Vries.

I have chosen the subject of circular urban area development because I have always been fascinated by complex construction projects with multiple actors. I find it very interesting to continuously innovate this sector, especially to focus on becoming more sustainable. I proudly present my graduation research and hope that my research will contribute to innovation of the development processes in the construction sector.

I would like to thank a variety of people who have contributed and participated in this research.

First, I wish to thank the interviewees of the case studies for their time and the knowledge that they shared during interviews. They have provided me with detailed information about the cases and their thoughts on CUAD. Next to the case study interviewees, I would like to thank Ronald van der Heijde, Mariska Vogel and Ernst Ten Heuvelhof. Through their insight on UAD, circularity and development processes the idea of applying the scrum methodology has started. Moreover, I wish to thank Walter de Vries, Lenno Pardon, Pim de Wit and Marielle Chartier for participating in the pilot study.

Secondly, I wish to thank my committee. I wish to especially thank Els Leclerc, who's insight on circularity and especially on structuring the report has guided me through this research process. I also want to express my gratitude to Els Leclerc for providing me with critical feedback and the opportunity to present my findings during the“ Circulaire Bouwprocess” seminar. Secondly, I wish to thank my committee. I wish to especially thank Els Leclerc, who's insight on circularity and especially on structuring the report has guided me through this research process. I also want to express my gratitude to Els Leclerc for providing me with critical feedback and the opportunity to present my findings during the "Circulaire Bouwprocess" seminar. Next, I would like to thank Jaco Quist, who has kept challenging me to review my analysis on the circular economy critically and motivated me with positive critical feedback. I would also like to thank professor Hans Bakker. The sharp and concrete notes of Hans Bakker have helped me to keep focussed and to keep improving my work. Furthermore, I wish to thank Isabelle Vries for giving me this opportunity to do a research for the PoR Authority, for critically evaluating my analysis from the business perspective and for actively participating in the pilot.

Last but not least, I would like to thank my parents. Who have always supported and motived me with feedback during my graduation process and also during my whole studies. Furthermore, I would like to thank my friends, family and boyfriend for all the support and especially for the needed distraction.

I hope you enjoy reading this master thesis.

Nesaneth van Slobbe
December 2019

SUMMARY

The Merwe Vierhavens (M4H) is an old harbour district close to the city centre of Rotterdam, which is redeveloped into a centre for innovative manufacturing. One of the objectives of the City of Rotterdam and the Port of Rotterdam (PoR) Authority is to designate the redevelopment of M4H as a pilot project for the circular economy in the built environment. Several studies have been conducted on urban metabolism and the possibilities of incorporating circularity in urban area developments in Rotterdam. Analysis of current material flows has been carried out for Test Site M4H, which resulted in an overview of potential opportunities to make these flows more circular. The outcome of this research also demonstrated that especially the construction material flow has great potential in becoming more circular. This mainly is due to the various parties that are already active on this theme within this area. Nevertheless, further actions have not been taken. One of the reasons for this lack of progress might be that the current urban development process does not fit the activities and strategies needed for circularity in urban development.

Circular urban area development (CUAD) requires a new process strategy, which fits the dynamic and complex environment of CUAD. Furthermore, previous research and pilots on the circular economy and circularity in the built environment have shown that CUAD requires practical tools that facilitate and accelerate the transition to CUAD. The objective of this research is, therefore, to develop a process framework that facilitates the transition to CUAD. This research answers the following research question: *What type of process strategy can facilitate the transition to circular urban area development of M4H?*

The procedure of this research consisted of three phases: a literature study, a case study research and a pilot study. Through these three phases, a process strategy for transitioning to CUAD is selected, and a framework is developed based on this process strategy. The first phase is focused on the literature study, in which circularity and urban area development are examined. Based on the literature study, the analytical framework is developed. Through the analytical framework, the (yet) undefined concept of CUAD is analysed. The analytical framework is based on circular ReSOLVE strategies in the built environment and urban development elements. The second phase of the research contains case study research. Two cases have been examined: the redevelopment of Binckhorst in The Hague and the development of Park 20I20 in Haarlemmermeer.

Based on the literature study and the case studies, 13 main conditions for the process strategy for the transition to CUAD are developed. These conditions formed the foundation for developing the process framework, described as the CUAD framework. During the last phase of research, this CUAD framework was tested through a pilot study, focusing on the development of a master plan for Galilei Park, part of M4H development.

The CUAD framework is a development framework that emphasises an iterative and flexible development process by means of a multidisciplinary team. The CUAD framework consists of three elements: events, roles and artefacts. By developing areas with a CUAD vision, through short cycles and by incorporating multidisciplinary perspectives, the CUAD framework aims to facilitate the complex and dynamic environment of CUAD.

From this study, the conclusion is drawn that CUAD is best facilitated through an adaptable process strategy, occurs through incremental steps and has a variety of involved stakeholders. The CUAD framework proposes this type of process strategy. The outcome of the pilot study concludes that the CUAD framework indeed can facilitate aspects of complex and dynamic urban development processes. However, the result of a pilot study is not generalizable because the pilot study is just designed for one specific case. Although the pilot study proved that the CUAD framework was successful in this particular case, the framework should be further developed to determine if the framework is also usable in other development processes. This, however, is in accordance with the findings of this research. Nonetheless, this research emphasises that CUAD is an ongoing learning process.

SAMENVATTING

Merwe Vierhavens (M4H) is een oud havengebied dicht bij het centrum van Rotterdam, dat wordt herontwikkeld tot het centrum voor de innovatieve maakindustrie. Een van de doelstellingen van de stad Rotterdam en het Havenbedrijf van Rotterdam is om de herontwikkeling van M4H een van de pilotprojecten voor circulaire economie in Rotterdam te maken. Er zijn verschillende studies uitgevoerd naar stedelijk metabolisme en de mogelijkheden om circulariteit te integreren in de stadsontwikkeling van Rotterdam. Het onderzoek van Team1010 heeft bijvoorbeeld geresulteerd in een overzicht van de potentiële stromen voor het implementeren van circulaire economie. Volgens de resultaten van dit onderzoek heeft de bouwstroom de meeste potentie. Echter, verder dan één onderzoek is het niet gekomen. Dit kan onder andere komen doordat het huidige gebiedsontwikkelingsproces niet goed past bij de aanpak die nodig is voor circulaire gebiedsontwikkeling.

Circulaire gebiedsontwikkeling heeft behoefte aan een nieuwe ontwikkelstrategie; een strategie die past bij de dynamische en complexe context van circulariteit. Daarnaast hebben eerder onderzoek en pilotprojecten aangetoond dat circulaire gebiedsontwikkeling behoefte heeft aan praktische hulpmiddelen die de transitie faciliteren. Het doel van dit onderzoek is dan ook om een model te ontwikkelen dat de transitie naar circulaire gebiedsontwikkeling faciliteert. In dit onderzoek staat de volgende onderzoeksvraag centraal: *Wat voor soort ontwikkelstrategie kan de transitie naar circulaire gebiedsontwikkeling van M4H faciliteren?*

De procedure van dit onderzoek bestaat uit drie fasen waarin eerst een ontwikkelstrategie voor de transitie naar circulaire gebiedsontwikkeling is gekozen, om vervolgens op basis van deze strategie een model te ontwikkelen. De eerste fase was gericht op het literatuuronderzoek, waarin circulariteit en gebiedsontwikkeling zijn geanalyseerd. Op basis van de literatuurstudie is het analytisch raamwerk ontwikkeld. Het analytische raamwerk geeft een praktische toetsing van wat circulaire gebiedsontwikkeling is, aan de hand van een casestudieonderzoek. Het analytisch raamwerk is gebaseerd op de circulaire ReSOLVE strategieën van de Ellen MacArthur Foundation(EMF) in de gebouwde omgeving en stedelijke ontwikkelingselementen. Twee cases zijn onderzocht in: de herontwikkeling van Binckhorst in Den Haag en de ontwikkeling van Park 20I20 in Haarlemmermeer.

Op basis van de literatuurstudie en de casestudie zijn 13 voorwaarden voor de ontwikkelstrategie voor de transitie naar circulaire gebiedsontwikkeling opgesteld. Deze voorwaarden vormen de basis voor het ontwikkelen van het model, ook wel het Raamwerk voor Circulaire Gebiedsontwikkeling (RCG) genoemd. Gedurende de laatste fase van dit onderzoek is dit raamwerk gevalideerd door middel van een pilotstudie. Er is een pilotstudie uitgevoerd die zich richtte op de ontwikkeling van het masterplan voor het Galilei Park, een deelgebied van M4H.

Het RCG is een ontwikkelmethode die de nadruk legt op iteratieve en flexibele ontwikkeling met een multidisciplinair team. Het RCG bestaat uit drie elementen: evenementen, rollen en artefacten. Het RCG pakt de complexe en dynamische context van circulaire gebiedsontwikkeling aan door het ontwikkelen van gebieden met een vastgestelde visie, door middel van ontwikkeling in korte cycli en door de integratie van multidisciplinaire perspectieven.

Uit dit onderzoek wordt geconcludeerd dat circulaire gebiedsontwikkeling behoefte heeft aan een ontwikkelstrategie met een aanpasbaar proces, dat plaatsvindt door middel van incrementele stappen, met een verscheidenheid aan betrokken stakeholders. Dit type ontwikkelstrategie is vastgesteld in het RCG. Aan de hand van de pilotstudie kan worden aangenomen dat het RCG inderdaad aspecten van complexe en dynamische gebiedsontwikkeling kan faciliteren. De uitkomst van een pilotstudie is echter niet te generaliseren, omdat de pilotstudie voor één specifiek geval is ontworpen. Bovendien moet het RCG, ondanks het succes van de pilotstudie, verder worden ontwikkeld.

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ABBREVIATIONS

C2C	= Cradle-to-Cradle
CE	= Circular Economy
CUAD	= Circular Urban Area Development
EMF	= Ellen MacArthur Foundation
EPA	= Environmental Planning Act
IABR	= International Architecture Biennale Rotterdam
M4H	= Merwe-Vierhavens
M4H+	= Merwe-Vierhavens plus nearby districts
PSS	= Product Service System
PoR	= Port of Rotterdam
RDM	= Rotterdam Droogdok Maatschappij
ReSOLVE	= Regenerate, Solve, Optimise, Loop, Virtualize, Exchange
UAD	= Urban Area Development
VROM	= Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer

1. INTRODUCTION

Source:(own work)

1.1 CONTEXT

Since several decades most of the harbour activities in the port of Rotterdam are moving from the city centre to deeper waters. The Port of Rotterdam (PoR) Authority is continuously redeveloping old industrial harbours and relocating harbour areas (Schoo, 2013). The PoR Authority is the owner, the operator and the developer of the Port of Rotterdam. The PoR is the tenth-largest harbours and one of the most connected harbours of the world. The core activities of the PoR Authority are the management and operation of the port, in which sustainable development plays an important role. Growing in a sustainable manner is one of the main objectives of the PoR Authority (PoR, 2019).

The Merwe Vierhavens (M4H) is an old harbour area located close to the city centre of Rotterdam. Like many other harbour activities, the harbour activities of M4H have been moved to the Maasvlakte near the North Sea. The Merwe Vierhavens belongs to the so-called "Makers District", which exists of two old abandoned harbour areas that located west of the city centre. These areas are M4Hand Rotterdam Droogdok Maatschappij (RDM). Together, these areas form the Rotterdam Makers District, a collaboration between the municipality of Rotterdam and the PoR Authority.

The goal of the Rotterdam Makers District is to develop the area into the centre for innovative manufacturing. Vivid urban harbour areas can drive the economy of cities, increase employment and increase the overall attractiveness of the city (Van Lier, van der Kroef, & Visser, 2010). The city of Rotterdam has always been a leading city when it comes to social sustainability and the quality of the living environment (Batten & Gehrels, 2018). With the Makers District, the city of Rotterdam wants to strengthen this image by increasing innovation and sustainability (PoR, 2019).

However, urban area development is currently a linearly organised process and hence not particularly sustainable. The construction industry uses large amounts of raw materials and produces a significant amount of waste and CO2 emissions. Almost 50 per cent of the total number of resources used in the Netherlands is consumed by the construction sector. This consumption leads to an enormous amount of waste (Van Lier, van der Kroef, & Visser, 2010). The construction sector, therefore, puts much pressure on the environment.

The Rotterdam Makers District formulated five objectives for the Makers District that are connected with the environmental policies of the city. The first objective is that the area has to become the district for innovative manufacturing. The area should be a place where both start-ups and large corporations are present. It should attract and facilitate working environments of all types of parties concerned with innovative manufacturing. Furthermore, the Makers District should be an open environment. It should be attractive for both knowledge institutes and corporations, as innovation is most optimal through mixed expertise (Van der Vegt & Jansen, 2003).

Moreover, the District should create job opportunities. Next to employment and innovative manufacturing, the fourth objective upholds that the district should include residential areas. The fifth and last objective of the development of the Makers District is that the area should become one of the leading places for pilot projects and experiments focusing on the circular economy in Rotterdam.

The Makers District will be developed through these five objectives, into a mixed area in which there will be, in addition to manufacturing, room for housing, hospitality and other urban functions while at the same time functioning as a pilot project for circular urban area development (CUAD) in Rotterdam.

Test Site M4H+ consists of M4H and the surrounding area and is destined to become a pilot project for circular urban area development in Rotterdam. Test Site M4H+ is a collaboration between International Architecture Biennale Rotterdam (IABR) and Rotterdam Makers District. IABR has examined the possibilities of a circular economy in Rotterdam by analysing the different flows that go through the city (Gemeente Rotterdam, IABR, .FABRIC, TNO, & IVb/MUSIC, 2014). The goal of Test Site

M4H+ is to investigate how the development of M4H can be connected to the possibilities of circular urban area development (Team 1010, 2019).

1.2 PROBLEM STATEMENT

Research and pilot studies have shown that a transition to circular urban area development (CUAD) is feasible from a technological point of view (Team 1010, 2019). Several pilots have been conducted to facilitate the transition to CUAD in the Netherlands. Numerous technical solutions are available for the transition to CUAD, like The Circular Kitchen (Jansen, 2019). Test Site M4H+ has also taken the first steps towards implementing CUAD, by analysing what needs to be done for CUAD and by listing the needs of stakeholders concerned with urban area development. In the past two years, research at Test Site M4H+ has resulted in a report, in which an action plan is described that is focused on a substantive solution for incorporating CUAD (Team 1010, 2019). However, no further steps have been taken since then. The halt is often due to the fact that the challenges lay in socio-technical barriers instead of technical implementation (Pomponi & Moncaster, 2017). Many times, these socio-technical challenges or obstacles have to do with the financial, structural or attitudinal aspects of businesses (Ritzen & Ölundh Sandström, 2017). For example, complex and overlapping regulations or uncertainties about cost and risks are significant barriers for the transition to CUAD. To illustrate, the material hub proposed by the research conducted at Test Site M4H+ raises questions concerning the ownership of materials. It is, therefore, necessary that the socio-technical barriers are managed correctly for a successful transition to CUAD (Tura, et al., 2019).

The Ellen MacArthur Foundation (EMF) emphasises that the transition towards a circular economy is in need of specific frameworks or strategies that facilitate the transition (Streule, Miserini, Bartlome, Klippel, & Garcia de soto, 2016; Prieto-Sandoval, Jaca, & Ormazabal, 2018). These are frameworks that facilitate corporate governance, cross-industry collaboration, technology or regulations for implementing circular economy principles (MacArthur, 2013). However, there are several constraints for developing a framework that facilitates the process of the transition towards circularity in the built environment.

First of all, the definition or the concept of circularity in the built environment is still vague and abstract, which makes facilitating the process difficult (Kirchherr, Reike, & Hekkert, 2017). Secondly, so far, only a few research studies discuss the process strategy needed for stakeholders in the transition towards a circular economy. And thirdly most development strategies for circular urban area development are focused on business models and procurement procedures (Prendeville, Cherim, & Bocken, 2018; Taranic, Beherens, & Topic, 2016; Streule, Miserini, Bartlome, Klippel, & Garcia de soto, 2016). However, pilots have shown the importance of the process strategy for implementing circular urban area strategies (Prendeville, Cherim, & Bocken, 2018; Nazareth, 2019). Therefore, the question arises on how the development process of CUAD should be organised to facilitate circular strategies.

From examining various development frameworks, it can be concluded that the characteristics of the stakeholders concerned with the development of M4H and the characteristics of CUAD do not fit traditional urban area development methods. Exploratory research concerned with the stakeholders of M4H and the ambition of the Rotterdam Makers District, for example, shows that the area attracts innovative companies that move fast and can swiftly adapt to change (Team 1010, 2019; van der Heijde & Vogel, architects, IABR Architects, 2019). Traditional urban area development methods, on the other hand, do not swiftly adapt to change.

Furthermore, CUAD is also in need of changes in the way how materials are used, the way the market operates and the legal procedures. The manner in which the urban area is developed is not easily adaptable to changes (Park & Peña-Mora, 2003). Thus, the implementation of circular urban area strategies in the development of M4H is best facilitated through a new process strategy for development. Guiding the process and the stakeholders are essential for CUAD and are considered a complicated process. Currently, most urban area development projects are developed according to

traditional urban development methods. Traditional urban development methods cannot quickly adapt to a dynamic environment (de Zeeuw, 2007). Moreover, research on Test Site M4H+ has indicated the need for a practical and hands-on approach for the transition to circularity in the built environment.

The focus of this research is, therefore, on the process strategy that is needed for the transition to CUAD of M4H. The objective of this research is to develop a practical tool or framework, which facilitates the process in the transition to CUAD by analysing the characteristics of CUAD according to current literature and through use of practical examples. This framework was also tested in the context of one particular case related to M4H, the development of the master plan for the Galilei Park.

1.3 RESEARCH QUESTION(S)

Research on Test Site M4H+ indicated the various needs of stakeholders concerning implementing circular strategies in the development of M4H. The research on Test Site M4H+ has identified what is necessary, but no further steps have been taken so far (Team 1010, 2019). One of the reasons for this halt is that the pilot projects and the ideas generated through the research were not concrete enough to be implemented by a network of actors.

The present research is therefore not focused on the question “what is necessary?”, but instead focuses on how CUAD should be facilitated. The objective of this research is to examine the process strategies that could facilitate the transition of M4H to CUAD, separately of neighbouring areas. The process strategy in the transition of M4H to CUAD was developed through the following research question:

What type of process strategy can facilitate the transition to circular urban area development of M4H?

This central question is answered by investigating four sub-questions. The sub-questions follow a sequence in which the first sub-question examines what CUAD is precisely by reviewing the concepts of circular economy and circularity in the built environment. The second sub-question concerns the process of urban area development, both the linear process as the (transition towards) a circular process. The third sub-question is related to the conditions for the process strategy needed for the transition to CUAD. The last sub-question aims to link the theory with practice by selecting a process development strategy that suits CUAD better than the current UAD model. Based on the chosen process strategy the process framework for CUAD is developed.

I. How can circular urban area development be defined?
II. What are the differences between traditional UAD and CUAD?
III. What are the conditions for the process strategy for the transition to CUAD?
IV. How should the process of CUAD be designed?

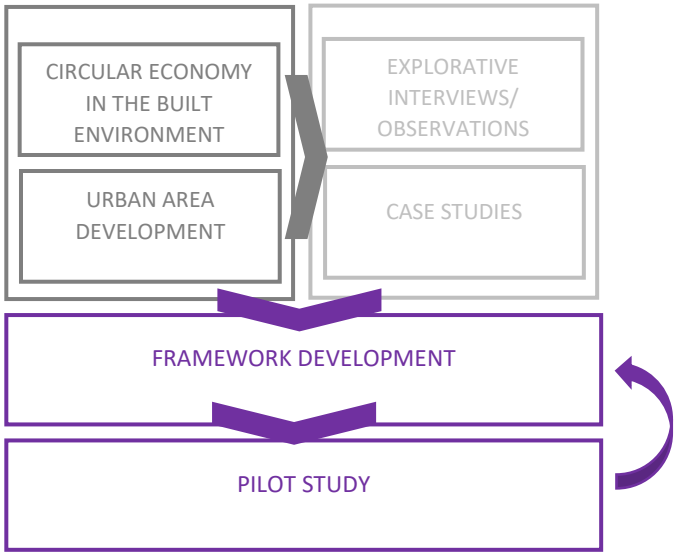
1.4 RESEARCH APPROACH

The objective of the research is to select a process strategy for the transition to CUAD and to develop a practical framework or tool based on this circular process strategy. The nature of the objective of the study and the research questions imply an explorative and qualitative research design (Baxter & Jack, 2008). The analysis of the process strategy needed for the transition to CUAD will, therefore, consist of both desk research and a field study.

Figure 1 is a visual representation of the structure of the research. Figure 1 shows that the study consists of three phases. The first phase is concerned with desk research; a literature study focused on circularity and urban area development. The second phase consists of two case studies in which current urban area development projects concerned with CUAD are analysed. Through the analysis of the case studies and the literature study, the process strategy that fits CUAD is selected. Based on this process strategy, the framework for CUAD is then further designed. This framework was tested and

finalised. The setup and results of this test are discussed in phase three, through the pilot study. This pilot study focused on the development of the master plan of Galilei Park in M4H.

FIGURE 1- STRUCTURE OF THE REPORT



SOURCE: (OWN WORK)

1.5 RELEVANCE

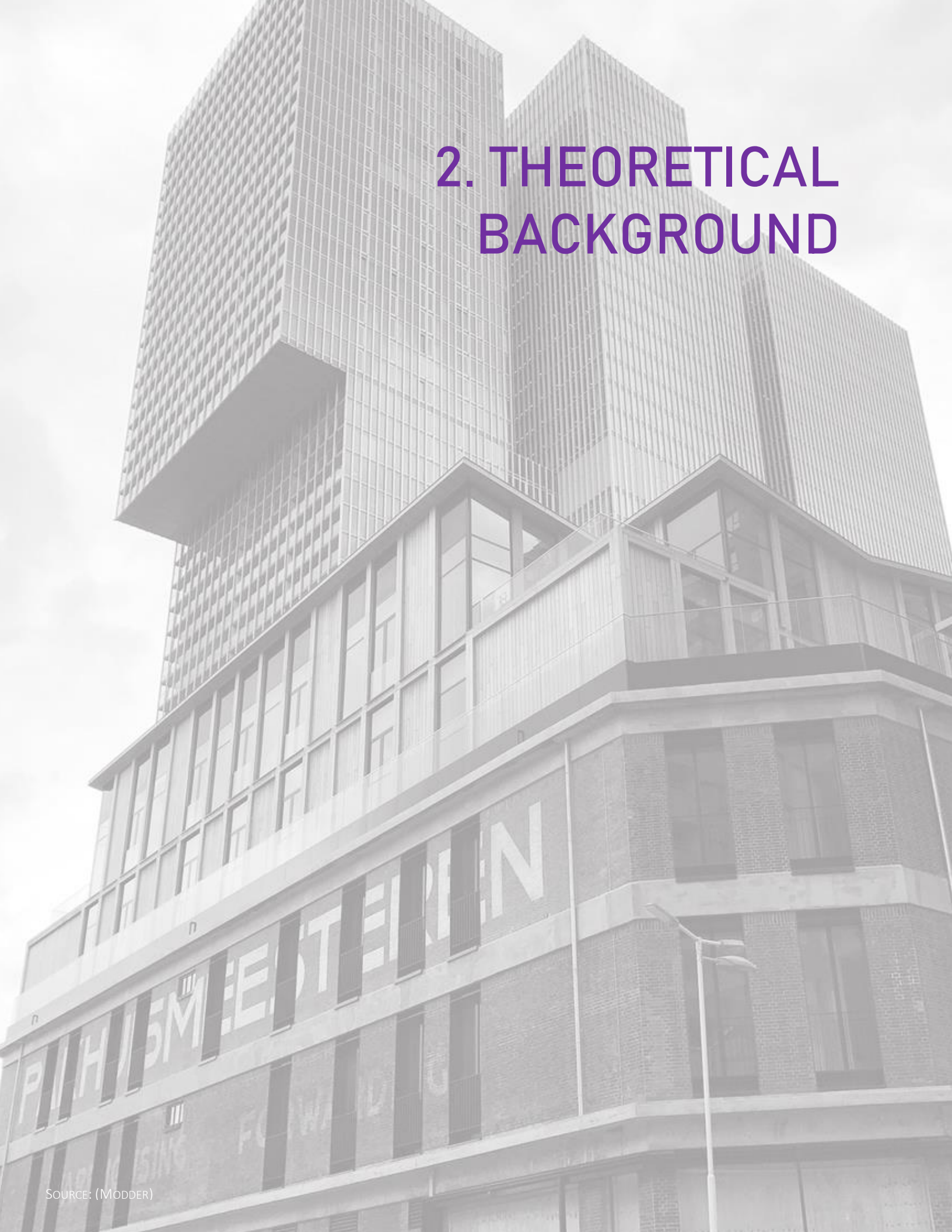
The circular economy is gaining popularity in the construction sector. However, the number of studies that concern CUAD is still relatively small. Moreover, various authors argue that most studies regarding CUAD are theoretical and have not yet had sufficient empirical support. Furthermore, most research that develops a tool for the socio-technical barriers of transition to CUAD is mainly focused on changing business models (Taranic, Beherens, & Topic, 2016; MacArthur, 2013; Gerding, 2019; Ritzen & Ölundh Sandström, 2017).

This research, however, contains practical relevance through the implementation of a process framework with a pilot study. The objective of the study is to develop a framework that facilitates the process of the transition to CUAD. This study, therefore, provides both practical relevance and theoretical relevance as it aims to develop a new type of framework for urban area development.

1.6 STRUCTURE OF THE REPORT

This study will further elaborate on the strategies needed for the transition of M4H to CUAD. In Chapter two, the theoretical background of both circular economy in the built environment and of urban area development is given through a literature study. Next, the research methodology is described in Chapter three. The research methodology outlines the applied case study research and the pilot study that was conducted. After that, Chapter four describes the cases and results of the case studies. In Chapter five, the practical process strategy or framework for CUAD is developed. The framework is tested with a pilot study, which is described in Chapter six. The process framework is modified in accordance with the results of the pilot study. The refined framework is defined in Chapter seven. Chapter eight of this report contains the conclusion, discussion and recommendations. The last Chapter concludes the report though a personal reflection and acknowledgement.

2. THEORETICAL BACKGROUND



Source: (Modder)

This Chapter describes the theoretical background of CUAD found in the literature. The objective of this research is to examine which process strategy facilitates CUAD to develop a framework for CUAD of M4H. To select a process framework for the transition to CUAD, the concept of CUAD has to be defined first. CUAD is described by first explaining the idea of the circular economy in the built environment and secondly by describing the UAD process.

The first Paragraph (2.1) elaborates on the definition of CE and the concept of CE in the built environment. The second Paragraph (2.2) describes the traditional UAD process applied in the Netherlands. However, the UAD process is changing. Section 2.3 elaborates on the changing approaches for UAD. The last Paragraph (2.4) concludes the literature study by describing the concept of CUAD through the analytical framework and the conditions for the process strategy for the transition to CUAD.

2.1 CIRCULARITY

The idea of the circular economy exists already for decades. Boulding (1966) was the first to mention a circular ecological system as an alternative to solve the scarcity of resources and decrease the amount of waste (Boulding, 1966). Our planet is currently dealing with a shortage of resources and increasing pollution (Tompkins & Adger, 2004). While on the other hand, the demand for materials and products is growing (Prior, Giurco, Mudd, Manson, & Behrisch, 2012). Therefore, it is becoming more evident that the current economic system is reaching its limits. Numerous studies have emphasized the need for a financial system that is not inherently wasteful.

2.1.1 THE CONCEPT OF CIRCULAR ECONOMY

The objective of the circular economy is in contrast with the current and traditional economic models. The traditional economic model, many times referred to as the linear economic model, is based on harvesting raw materials to develop products and discard those products as waste. The idea of the circular economy is creating economic prosperity without harming the environment. Or in other words, economic growth has to be seen separately from the use of (raw) materials.

In recent years the number of research done on sustainable economic systems has grown (Geissdoerfer, Savaget, Bocken, & Hultink, 2017). After Boulding more researchers discussed the circular ecological system. Nevertheless, the interest in the circular economy has gained primarily through the Ellen MacArthur Foundation (Kirchherr, Reike, & Hekkert, 2017). The increasing interest and number of studies also have led to a variety of definitions and schools of thought.

Some authors emphasize a completely closed system, like Smiths and Linderhof (2015) who argue that "*CE exists when cycles close and no residual waste exis*ts" (Smits & Linderhof, 2015). Authorities like the European Commission defines CE less strictly and argues that CE is "*An economy in which products, materials, and resources keep their values as long as possible and in which waste production is minimal*" (European Commission, 2014). Several studies have tried to summarize the views on CE. For instance, the study of Kirchherr, Reike, and Hekkert (2017) analyse 114 definitions of CE. Kirchherr and colleagues argue in their research that the concept of CE requires coherence. Without coherence, the concept of CE will just become a trending word instead of a working concept. However, the study also emphasizes that the concept of CE can never be fully captured in one simplified definition (Kirchherr, Reike, & Hekkert, 2017).

CE ACCORDING TO THE ELLEN MACARTHUR FOUNDATION

The CE concept developed by the EMF is a combination of the different schools of thought that are concerned with decoupling and decreasing waste. These schools of thought are the Performance Economy, Industrial Ecology, Regenerative Design, Biomimicry, Cradle-to-Cradle (C2C), Blue Economy and the Natural Step (MacArthur, 2013; Mentink, 2014). Although these schools of thought differ in their design, focus area, and economic perspective, all theories have the following aspects in common: the decoupling of economic growth and the use of materials, decreasing waste, waste value creation, and

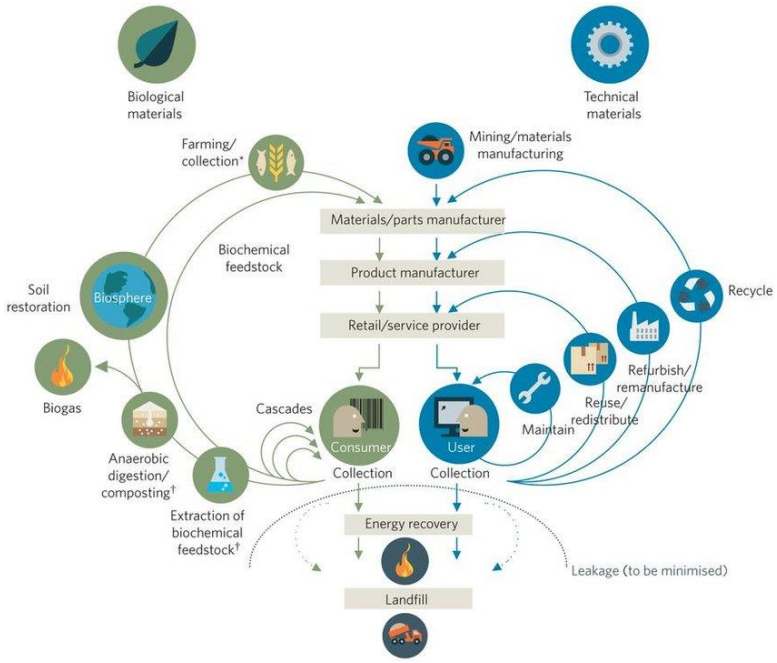
system-based innovations. For example, the C2C theory focuses on increasing business market positions by creating value through the circular advantage of waste (Braungart, McDonough, & Bollinger, 2006). Meanwhile, the focus of the Performance Economy is on decreasing residual waste and the usage of materials by product-service systems. This theory aims at the payment for use and services instead of ownership (Tukker, 2015).

This research follows the CE concept developed by the Ellen MacArthur Foundation, which has broad academical and social recognition. The EMF defines the circular economy as "a *framework that redefines growth and focuses on benefits for society through closed loops with cycles and cascades*" (MacArthur, 2013). As described, many definitions of CE exist, and many studies do not follow the definitions of the EMF. Numerous studies develop their definition of CE through their research. The EMF, however, is one of the most well-known organisations that emphasizes and teaches the circular economy and the definition of the EMF has been referred to in many studies (Korhonen, Nuur, Feldmann, & Eshetu Birkie, 2018). Furthermore, this research focuses on defining the concept of CUAD rather than that of CE itself.

The EMF emphasizes, like other CE schools of thought, that a distinction is made through two ecological loops, the biological loop, and the technical loop. The biological loop consists of materials that can be returned to nature after being used, while the technical loop consists of materials that can be (almost) wholly reused. This loop system is visualized by the Figure 2. Moreover, the circular economy and the circular loops rely on three principles, which are (Ellen MacArthur Foundation, 2015a, p. 6):

Principle 1- *Preserve and enhance natural capital by controlling limited stocks and balancing renewable resource flows.*
Principle 2- *Optimise resource yields by circulating products, components, and materials at the highest utility at all times in both technical and biological cycles.*
Principle 3 - *Foster system effectiveness by revealing and designing out negative externalities*

FIGURE 2- THE CIRCULAR ECONOMY



SOURCE: (ELLEN MACARTHUR FOUNDATION, 2015B)

The double loop system rests on three fundamental principles which can be translated into six regulatory actions. Together these actions form the ReSOLVE framework of the EMF. The six actions are Regenerate, Share, Optimise, Loop, Virtualise and Exchange. The ReSOLVE framework represents six categories of activities that are related to business opportunities in the transition from a linear economy towards a circular economy (Ellen MacArthur Foundation, 2015b). Table 1 shortly describes the six actions.

TABLE 1- STRATEGIES OF THE RESOLVE FRAMEWORK

RESOLVE FRAMEWORK	
Regenerate	The shift to renewable energy and materials. Actions should reclaim, retain, and regenerate the health of ecosystems and return recovered biological resources to the biosphere (Ellen MacArthur Foundation, Delivering the circular economy: A toolkit for policymakers, 2015b, p. 23)
Share	The duration of the lifecycle of a product should be long and maximize utilization of products, by sharing them among different users, by reusing them through their entire technical lifetime and by prolonging their life through maintenance, repair, and design for durability.
Optimise	Increasing performance and efficiency of a product. Remove as much waste in the product and supply chain. Optimise products without changing the actual product of technology.
Loop	Keep components and material in closed loops. That means remanufacturing and recycling of products or design products that are infinite.
Virtualise	Dematerialise products by virtualisation like e-books, online shopping, and autonomous vehicles.
Exchange	Replace old with new and non-renewable materials. New products and services with less impact.

SOURCE: (ELLEN MACARTHUR FOUNDATION, DELIVERING THE CIRCULAR ECONOMY: A TOOLKIT FOR POLICYMAKERS, 2015B)

Despite the increasing interest of both scholars, public and private actors, the transition towards circularity is still in its infancy. The practical implementation of CE principles is still modest through the linear nature of most business processes. The transition towards the CE requires changes in business models, collaboration and processes (Leising, Quist, & Bocken, 2018). Tura et al. examined the most common drivers and barriers for the transition to CE. Through the research into the drivers and barriers of transition to CE, seven areas are distinguished: environmental, economic, social, political and institutional, technological and informational, supply chain and organizational factors. The drivers and barriers can be translated into the conditions for the transition towards the circular economy (Tura, et al., 2019). The drivers and barriers found by Tura et al. can be found in the Appendix A1.

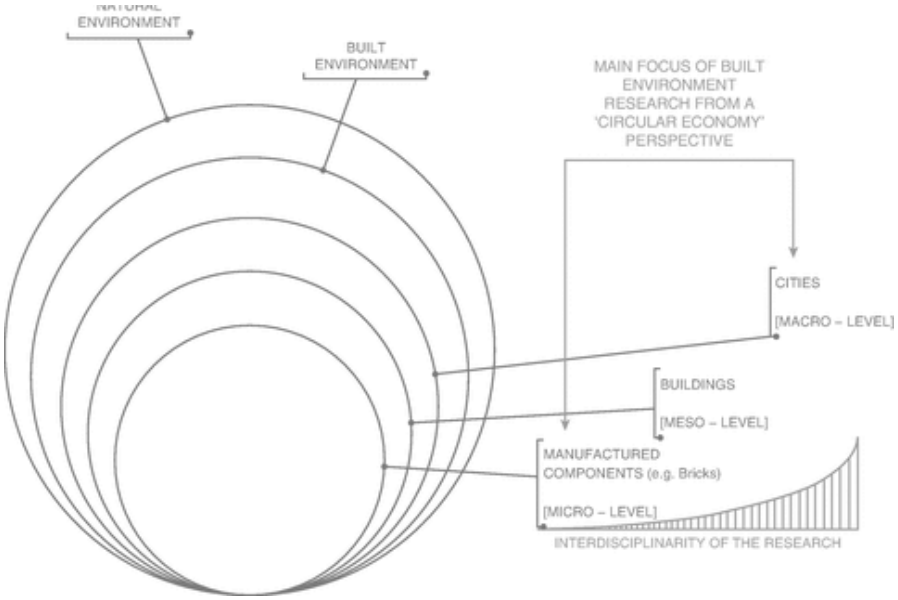
2.1.2 CIRCULAR ECONOMY IN THE BUILT ENVIRONMENT

The impact that the construction sector has on the environment has led to an increasing interest in sustainable approaches for the construction sector (WEF, 2016; Prendeville, Cherim, & Bocken, 2018; Wijsmuller, 2018; Circle Economy, .Fabric TNO, & Gemeente Amsterdam, 2019).The construction sector is responsible for 25-40% of global dioxide emissions (WEF, 2016). Next to this, the construction sector is the number one sector when it comes to consuming raw materials. The increasing interest in a different approach towards the use and reuse of materials in the construction sector is one of the reasons that the concept of a circular economy in the built environment is of growing importance. The urgency to build more sustainably is becoming more and more recognized (Silverstre, de Brito, & Pinheiro, 2013). However,

it is still unknown what circularity in the built environment is, how it should be defined, and how circularity should be measured. Moreover, numerous debates and arguments can be found on the differences or similarities between circularity and sustainable. Are circular buildings part of the sustainable built environment or is sustainability part of the circular economy in the built environment (Geissdoerfer, Savaget, Bocken, & Hultink, 2017)?

Pomponi and Moncaster identified two important bottlenecks for the implementation of CE in the built environment (Pomponi & Moncaster, 2017). The first conclusion they draw is the fact that the general assumptions of CE are concerned with short-lived products, while the average lifespan of a real estate building is generally more than 70 years (Gijsbers, 2006). The second argument made about the perspective of CE in the built environment is concerned with the level of implementation. A distinction should be made between the micro-level, macro-level and meso-level (Pomponi & Moncaster, 2017). Most studies and pilots have been done on the micro-level or the meso-level, meaning on the building materials or buildings itself. Meanwhile, urban area development is related to both the meso-level and the macro-level. Urban area development can be seen as one big project concerning the development of a city or district, which entails various building projects (Franzen, Hobma, de Jonge, & Wigmans, 2011). Studies were done on implementing circular strategies on the macro -level, the urban area, are scarce (Prendeville, Cherim, & Bocken, 2018). Figure 3 displays the different levels of the built environment and how these are related to circularity.

FIGURE 3- FRAMING THE RESEARCH ON CIRCULARITY IN THE BUILT ENVIRONMENT



SOURCE: (POMPONI & MONCASTER, 2017)

MESO-LEVEL: THE CIRCULAR CONSTRUCTION PROCESS FOR A SINGLE BUILDING

Platform CB'23 is a collaboration between several construction firms, research institutes and governmental agencies who have tried to develop an unambiguous concept of circular construction (circular bouwen) in the Netherlands. By defining the concept of circular construction, Platform CB'23 developed a framework for the transition towards a circular building process.

The framework consists of the seven main subjects of circular construction. These subjects are the framework, circular design and construction, measurement of circularity, information and data, value creation, guarantees and network transformation (Platform CB'23, 2019). The starting point for circular construction is the construction process. Five phases are distinguished within this process: the initiation, the design phase, the construction phase, and the renovation or redevelopment phase and lastly the

demolishment phase. The phases of the construction cycle are quite similar to the traditional construction process. However, some significant differences exist. First of all, the circular construction process is an iterative and interactive process. The circular construction process consists of five phases, while the traditional construction process consists only of four phases. The circular construction process adds the reuse phase as part of the project.

Furthermore, circular construction requires interaction between the phases while in the traditional construction process, the phases are separated. In addition to this, the circular construction process does not have a fixed beginning or end. This undefined beginning or end entails that in each phase, it has to be considered what will happen next. Another aspect that is important for circular construction is the learning concept. The number of circular buildings and the variety in which buildings can be circular grows through increasing knowledge and innovations (Platform CB'23, 2019). Sharing knowledge is, therefore, essential. One of the main subjects of circular constraint then is the transformation of the network. The circular building process assumes changing roles, responsibilities, and agreements throughout the phases and the cycles. The iterative and interactive process of circular construction is described in Appendix A2.

The circular construction framework of Platform CB'23 aims to develop a general definition and work form for the circular construction process. Currently, the framework is mostly focused on one of the most technical challenges of CE in the built environment: measuring circularity. Tools to measure how 'circular' a building does not exist yet. However, the 10r model of Plan Bureau Nederland (PBL) indicates levels of impact of circular strategies (Potting, et al., 2018). 10r model can be found in Appendix A3. Furthermore, the framework indicates the need for managerial changes like agreements and changing roles and responsibilities for successfully implementing the circular construction process (Platform CB'23, 2019). The changing roles and responsibilities, however, have not been defined yet through the framework of Platform CB'23.

MACRO-LEVEL: URBAN METABOLISM AND CIRCULAR STRATEGIES

The first step of examining possible circular economy strategies in cities is examining urban metabolism. Urban metabolism is seen as fundamental for developing 'sustainable' cities (Kennedy, Pincetl, & Bunje, 2011). The concept of urban metabolism finds its origin in the 1950's and can be defined as "*the total sum of the technical and socio-economic processes that occur in cities, resulting in growth, production of energy, and elimination of waste"* (Kennedy & Cuddihy, 2007, p. 44). The school of CE is focused on eliminating and decreasing waste by closing off material cycles. By analysing the flows through urban metabolism analysis, strategies can be developed to transform current linear flows into closed circular flows.

Urban metabolism has, in general, a quantitative nature. The urban metabolism indicates how different flows are functioning, to be able to improve the urban system of flows. For example, how much food is imported, exported or thrown away in the city of Rotterdam (Gemeente Rotterdam, IABR, .FABRIC, TNO, & IVb/MUSIC, 2014)? CUAD, however, is more than just urban metabolism, because urban metabolism does not give a strategy on how to link the flows or transform the flows from linear flows to circular flows. CUAD does take the implementation of CE strategies on the macro-level into account.

Not many studies are focussed on the implementation of CE strategies on the macro-level. One of the few recent studies that have been done on the implementation of the CE perspective in European cities is the research of Prendeville, Cherim and Bocken (2018). The objective of the research is to explore the transition to a 'circular city' by examining the approaches of six cities in Europe. The research of Prendeville, Cherim and Bocken (2018) examines the cities are Amsterdam, Rotterdam, Glasgow, Haarlemmermeer, The Hague and Barcelona. The research indicates that Rotterdam, for example, is rather pragmatic to establish plans that overrule the policy cycle. The 'circular city' is defined in the research through a conceptual framework which is based on the ReSOLVE framework of the EMF. The

circular city framework evaluates the ReSOLVE activities through both top-down and bottom-up interventions (Prendeville, Cherim, & Bocken, 2018).

From the circular city framework, it can be concluded that for implementing the CE in the built environment it is of importance to put it on the political agenda, consider the city context and engage all stakeholders to be able to overcome the barriers of CE implementation. However, from the literature and through research, it is clear that a circular city vision is still missing. It is up to the policymakers to provide clear guidelines for the transition while keeping the circular city concept open for debate so that the circular city is developed in partnership with the city stakeholders (Prendeville, Cherim, & Bocken, 2018). Moreover, the circular city framework shows that a collaboration platform for the stakeholders of the construction sector affects all aspects of the circular economy, and therefore on all the characteristics of the ReSOLVE framework.

The framework of Prendeville, Cherim and Bocken (2018) has shown the current perspectives and activities of the transition to CE in several European cities. However, the existing activities mapped out in the research have not shown their effect yet on urban sustainability. Furthermore, the framework has shown the current bottlenecks and emphasizes the need for a shared vision on the transition towards a CE in cities. However, the framework does not define a strategy or tool to achieve these shared visions. Furthermore, the cases shown in the research, such as a collaboration platform and a regulatory framework, are loosely defined examples and need to be worked out in more detail.

2.1.3 Conclusion circularity in the built environment

While numerous definitions exist about the concept of CE alone, CUAD is still undefined. CUAD is related to different time scales and levels of implementation. It is concerned with both the building, or meso-level, and the area, or macro-level. Next to this, CUAD can be related to a variety of types of flows for buildings and districts, like waste, water and energy. This research, however, is solely focused on the construction flows. Furthermore, because of the different thoughts on CE and CE in the built environment, this research will follow the circular strategies of the EMF for CUAD on a macro-level. Not many theories exist already on CE in the built environment. The concept of the circular construction process of Platform CB'23 is currently leading, from a national and governmental perspective, for CE in the built environment on meso-level in the Netherlands and will, therefore, be followed for CUAD on a meso-level (Platform CB'23, 2019).

Examining CUAD through both the meso-level and macro-level the conclusion can be drawn that the transition to CUAD requires both technical and managerial changes. Technical innovations and changes are related to aspects such as optimisation of circular material loops and measuring circularity. Managerial innovations or changes are related to socio-technical barriers of implementing CUAD and linking flows and people. This research is focused on the process strategy for the transition to CUAD. However, the process of CUAD cannot be separated from the substance or technical aspects of CUAD.

Examining the process strategy for the transition to CUAD the assumption can be made that CUAD requires a multidisciplinary approach. This implies that all relevant stakeholders are engaged and that the implementation is not done from the perspective of just one discipline. CE in urban development should be examined from a technical, economic, environmental and social point of view. Furthermore, research has shown the importance of an iterative and interactive process in which learning occurs. The new circular construction process will affect the roles and responsibilities of the actors. And lastly, CE in urban development requires a steering body. Policy interventions and regulations are, therefore needed.

2.2. THE TRADITIONAL URBAN AREA DEVELOPMENT APPROACH

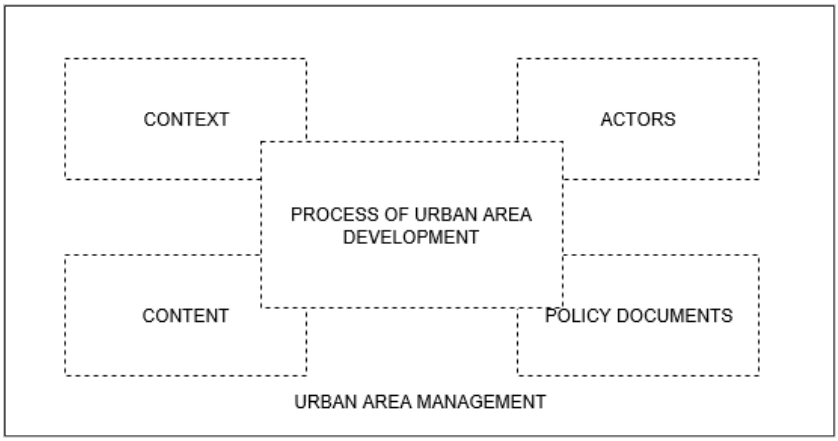
Urban development, urban planning, spatial planning and urban area development are all concepts related to the broad range of activities captured by the Dutch word “gebiedsontwikkeling”. This research will follow the definition and theories of Franzen and colleagues (2011), who translate

"gebiedsontwikkeling" as urban area development (UAD) (Franzen, Hobma, de Jonge, & Wigmans, 2011). The differences between UAD and for example, spatial development is that UAD is focused on an urban district while spatial planning can include all kinds of area development projects. Furthermore, urban planning is predominantly spatially oriented and more concerned with the result (usually a plan) while urban development is more concerned with the process. Lastly, urban planning and urban development are both focused on the city as a whole, while urban area development is typically related to a specific geographical location.

In this study, UAD is defined as the development and shaping of an urban district by means of a vision (van Rooijen, 2009; Franzen, Hobma, de Jonge, & Wigmans, 2011). UAD is a process that includes many (large) projects which entail various actors. Governing the process of area development is defined as urban area management. Urban area development is always interwoven within the social context, and the traditional urban area development approach depends on five elements, according to Franzen and colleagues. The five elements are the process, context, the actors, the content and the policy documents. These five elements are visualized in the model, which is a schematic overview of urban area development (Figure 4).

Next to the theory of Franzen and colleagues on traditional urban development, several other theories exist. This research will follow the theory of Franzen and colleagues because it follows the traditional urban development process as applied by the Dutch ministry of housing (VROM, 2009; VROM, 2011).

FIGURE 4- THE TRADITIONAL URBAN AREA DEVELOPMENT APPROACH



SOURCE: (FRANZEN, HOBMA, DE JONGE, & WIGMANS, 2011)

2.2.1 THE PROCESS

UAD always starts with the exploitation of available land. The exploitation of the land has a large influence on urban area development because it affects the exploitation, the process, the actors involved and the policy documents needed for the realisation (Wolting, 2006; de Zeeuw, 2007).

LAND EXPLOITATION

Five different types of collaboration models for land exploitation exist, which are the traditional model, the building claim model (Dutch: Bouwclaim model), the joint-venture model, the concession model and the exploitation agreement. The choice of collaboration model is dependent on several factors, like the local and political context, the characteristics of the area and ownership of the land (Franzen A. , Hobma, de Jonge, & Wigmans, 2011; de Zeeuw, 2007).

In the traditional model and the building claim model the land exploitation is done by a public authority, the municipality. Public land exploitation entails that the municipality is the owner of the land.

The municipality decides, therefore, on the planning, the feasibility and the procedures of the development and exploitation of the land (VROM, 2009).

In the joint-venture model, the land is exploited by both public and private parties through one enterprise. Both public and private parties have control over the land, but both also bare the risks.

The last group of land exploitation models consists of private party land exploitation. Two models exist, the concession model and the exploitation agreement (Dutch: Explotatie-overeenkomst). In both the concession model and the exploration agreement, the municipality limits the tasks through general requirements of public law. The differences between these models are the division of risks and costs for the development of the land and the building exploitation (VROM, 2009).

PHASES

Traditional spatial development processes are often described as linear processes (VROM, 2009; Franzen A., Hobma, de Jonge, & Wigmans, 2011) The spatial development process in the Netherlands consists of four phases (VROM, 2009). Each phase describes the roles and responsibilities of the actors involved in that part of the development process and each phase is summarized by a decision document. The decision document is a written agreement of the decisions, roles, and responsibilities made in the process. The four phases of the spatial development process are the initiation phase, the feasibility phase, the realisation phase, and the exploitation-management phase.

Initiation phase

During the initiation phase, the decision is made if the proposed urban development has sufficient support, and if no other or better alternatives exist. The initiation of urban development can arise from market initiatives by private actors with land or real estate positions, from unsolicited proposals by coalitions or policy intentions. The initiation phase entails a general plan of the goals and the involved parties and their roles and responsibilities. Furthermore, during the initiation phase, the master plan is developed. The master plan is a general urban development vision with the program of requirements and is the basis for further development of the area (Sorel, Buitelaar, van den Broek, Galle, & Verwest, 2011). The master plan is developed in more detail by the urban plan (Trentelman, 2011). Next to this, the acquisition of lands and land ownership is one of the most critical aspects of the initiation phase.

Feasibility phase

The feasibility phase consists of three sub-phases and is also referred to as the planning phase. Through the feasibility phase, a design is made that fits within the framework of public law. The three sub-phases are the define phase, the design phase, and the preparation phase. The define phase consists of drawing the conditions for the public law framework like the zonings plan. The design phase continues the define phase and delivers a design that fits within the framework of the conditions from the public law framework. The last phase is the preparation phase in which the plan for the realisation is made. The process of going through the sub-phases, however, is chaotic and iterative rather than sequential (van Rooijen, 2009).

Realisation phase

The realisation phase consists of the actual implementation of the plans made for the development in the feasibility phase. This phase consists of activities like the division of roles and responsibilities, risk management, involving the right people, agreements on ground routing and independent appraisals (VROM, 2009).

Exploitation-management phase

The exploitation phase is the last phase of the development process and is also the phase in which the realization of the actual development begins. In this phase, the ownership is transferred to the end-users. The exploitation of the area entails the maintenance of the area indirectly. A difference exists between the maintenance of public spaces and buildings. The division of the maintenance responsibilities is decided upon in the previous phases (Franzen, Hobma, de Jonge, & Wigmans, 2011).

2.2.2 THE CONTEXT

City development is influenced by changes in society, the economy and the environment. A city must adapt to social demands and needs if it wants to be a continuously attractive place to live and work. The urban area approach, therefore, needs to anticipate this context, both the social context and the policy context. However, translating social developments into spatial dynamics is a challenging but rewarding subject (van t Verlaat & Wigmans, 2011). Urban area development should take the context of the city into account to anticipate social developments, but also because social developments affect the development itself.

2.2.3 THE INVOLVED ACTORS

The number of parties concerned with spatial development can be quite extensive. The actors of urban development can be categorized as shareholders or stakeholders. Shareholders and stakeholders are both involved actors. However, a shareholder always has a financial interest through stocks or shares. A stakeholder, on the other hand, is impacted by the outcome of the project but this impact does not necessarily have to be related to the financial aspects of the project (Freeman & McVea, 2001). Another classification is by categorizing involved stakeholders in public parties and private parties. However, within the public parties and private parties, a distinction can be made as well. Lastly, besides public and private parties, civil society organisations exist. The civic societies are interest groups which can be both public and private organizations. Several methods exist for collaboration between different entities. A method that includes all types of entities is the quadruple helix. This theory emphasizes collaboration between public authorities, market parties, research institutes and civic groups (Colapinto & Prolezza, 2012).

Public parties

Different public authorities have different interests in UAD. The national government and provincial governments for example mostly value the quality of the spatial use, while the main focus of the municipalities is on creating more political and local support (van t Verlaat & Wigmans, 2011). The national and provincial government are included in the process of UAD. However, it is the municipality that genuinely is involved in UAD.

The municipality is actively involved in the process of UAD and can take several roles. Adams and Tiesdell (2010) define four types of activities the municipality can undertake. These four types are shaping, regulating, stimulating and activating. Like various other researchers, Adams states that the municipality no longer solely has a role in land exploitation but also has a complex steering role (Heurkens, 2013) (Adams & Tiesdell, 2010). The municipality is becoming a part of the market, and through this, the municipality can influence both the market and the market parties (Heurkens, 2013)

Private parties

The role of the government is changing since 1970, and currently, all UAD projects are conducted through Public-Private Partnership (PPP) (VROM, 2009). The increasing complexity and risks of spatial development have changed the role of market parties. Nowadays, market parties will sometimes already be engaged in the planning phase. The private parties or the market parties can be classified as project developers, investors, contractors, and housing corporations. The project developers realise the project and purchase the land. The project developer can be seen as the client of the contractors. The contractors are mainly focused on the continuity of the construction. It is important for them to be involved early in the project. The investor is the owner of the finished project and does, therefore, not bare the development risks. Housing corporations have social responsibilities, which entails, for example, building houses for lower incomes (van Dijk, 2011).

Despite working on the same project, most parties have their interests. For example, most project developers are focused on current developments and quick wins while most investors are looking at the value of a project in the longer run.

Citizens and interest groups

The actor category of citizens and interest groups is essential and often includes a wide variety of interests. For example, shop owners often have quite a different view on infrastructure and car parks than environmental groups or residents. The complexity of urban area development lies in the fact that it is necessary to take many actors and their views into account while making decisions.

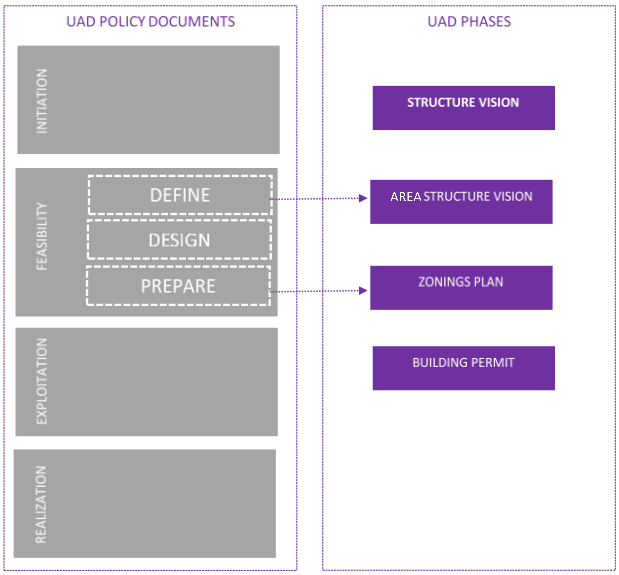
2.2.4 THE CONTENT

The content of UAD is based on creating spatial environments in the city with a variety of uses. UAD can be focused on creating residential areas, car parks, and business areas. Urban areas can be solely for one type of user or can be a mixture of different types of uses. A mixture of different practices can be beneficial for the attractiveness and liveability of an area.

2.2.5 POLICY DOCUMENTS

The UAD process consists of four phases. Each phase ideally will be finished with a policy document or a contract. The agreements made in the policy documents are then the start of the new phase. Figure 5 visualizes that each process phase should be finished with a policy document. Three policy documents exist the structure visions which consist of the general structure vision and area-specific structure vision (Dutch: de structuur visies), the zonings plan (Dutch: bestemmingsplan) and the building permit (Dutch: omgevingsvergunning bouwen) (Rijkswaterstaat, 2019). See Figure 5 for the four phases of the UAD process and the associated policy documents.

FIGURE 5- POLICY DOCUMENTS OF UAD



SOURCE: (RIJKSWATERSTAAT, 2019)

2.3 CHANGING URBAN AREA APPROACHES

Several theories exist on how to facilitate strategic decision making in UAD. The traditional model for urban area development, or the so-called top-down model, is focused on 'command and control'. Decisions are made by public authorities through a fixed zonings plan. Various studies argue that the traditional model is no longer accurate and efficient because of the growing complexity of area development. Area development is becoming complex through the growing number of actors and the changing role of public authorities (Heurkens, 2013; Franzen A. , 2011).

Some authors state that the underlying problems can be identified by looking at the differences between the preferred stated and the current state (Bramezza, 1996; Kearns & Paddison, 2000). The theory of Bramezza (1996) defines superior urban development as a condition for urban development (Bramezza, 1996). However, the question arises: what is the ultimate superior state? Therefore, Van der Berg and colleagues (1996) argue that UAD requires an integrated strategy because urban area development needs to take the social, economic and politic objectives into account (Van den Berg, Braun, & Van der Meer, 1996). The multidisciplinary approach of the integrated strategy fits the current trend of the growing number and variety of stakeholders in UAD.

2.3.1 THE INTEGRATED STRATEGY

The integrated strategy of urban area development needs vision, organising capacity and city marketing (Franzen, Hobma, de Jonge, & Wigmans, 2011). A development vision is focused on an integrated strategy for the future of the city. A vision is a general overview of the desired development of a city based on trends and preferences. The organising capacity is the actors and resources that are necessary to achieve this vision. Organising capacity is most efficient when all stakeholders participate, new ideas are generated, and relevant policies are developed (van Hoek & Wigmans, 2011).

An essential aspect of urban development is to make an area attractive to live or work. City marketing is a tool to attract people by promoting the city's services and attractions. City marketing is in contrast with traditional urban development, which is mainly focused on government regulation while city marketing is more focused on regulation through market initiatives (Franzen, Hobma, de Jonge, & Wigmans, 2011; Braun, 2008).

The integrated strategy theory is a useful theory that takes the critical aspect of collaboration in UAD into account. However, the integrated theory and particularly the organising capacity model raise some questions. First of all, the integrated theory states that there is a need for an integrated vision. A vision for the development of an area is indeed crucial. However, the integrated theory states also that this vision should not be achieved through top-down steering. Therefore, the development of urban areas is more concerned with the process of developing an integrated vision than achieving that vision.

The second element of the integrated theory that raises questions is the organising capacity model. The organising capacity model emphasizes the importance of the actors in urban area development. The focus on cooperation between actors is indeed important for UAD. However, the focus should not only be on natural cooperation and shared visions (Franzen, Hobma, de Jonge, & Wigmans, 2011). Because in reality, cooperation between actors does not always come naturally or will be open and transparent. Furthermore, the organising capacity model declares that cooperation only can work through mutually shared goals and interests. However, actors in a network do rarely have mutual goals and interest, which leads that this model does not provide any solutions for problems between actors. A correct cooperation model should take the diversity of the actors into account.

Franzen and colleagues (2011) argue that urban practices need a new theory (Franzen, Hobma, de Jonge, & Wigmans, 2011). A theory that shapes the vision of the "projects" during the process, takes the diversity of values and goals of the actors into account and considers conflict management as an integral part of the cooperation- and interaction process. Therefore, urban area development needs an approach that includes the network environment of urban area development (de Bruijn & Ten Heuvelhof, 2008). The changing UAD process requires an integrated approach that takes into account the complexity of the network environment of urban area development projects. An approach that ensures openness and transparency, the protection of core values, progress and substance (de Bruijn, Ten Heuvelhof, & In 't Veld, 2003)

2.4 CONCLUSION

From the concepts of circularity and urban area development, the assumption can be made that circular urban area development (CUAD) is related to strategies to implement CE in the built environment through the process of urban area development. However, both the concept of the circular economy in the built environment and urban area development are up for discussion. Moreover, CUAD is still undefined and still often not applied. The literature study concludes, therefore with how CUAD should look through the conditions for the process strategy of the transition to CUAD.

2.4.1 CIRCULARITY IN THE BUILT ENVIRONMENT VERSUS UAD

CE in the built environment and UAD are both concerned with changing complexity through integrated disciplines and increasing the number of stakeholders in the built environment. Furthermore, both concepts are related to both the meso-level and macro-level of implementation.

On a meso-level CE in the built environment can be defined by the circular construction process of Platform CB'23. Platform CB'23 aims to define a general concept for circular construction projects in the Netherlands. Circular construction projects are defined by five phases (Platform CB'23, 2019). Despite the fact, the Platform CB'23 emphasizes the need for changing roles and responsibilities, the framework developed by Platform CB'23 does not include which roles and responsibilities should play a role in the circular construction projects. Nevertheless, the substantive or technical aspects of CUAD cannot entirely be decoupled from the managerial aspect of the transition to CUAD. Next to this, Platform CB'23 is concerned with the circular construction of a building, not with the development of the whole area.

From the analysis of the macro-level of implementing CE in the built environment, the conclusion can be drawn that CUAD is still an undefined concept. However, Pomponi and Moncaster have developed a successful framework for analysing circular cities (Pomponi & Moncaster, 2017). This framework is based on the ReSOLVE framework of the EMF. The ReSOLVE framework is a popular tool to examine circular strategies in business but also in construction projects. In 2016 for example, a collaboration of BAM, BRE, cd2e, London Waste & Recycling Board, Ouroboros, Tarkett, and Turntoo examined the ReSOLVE framework on several construction project cases (CE 100 network, 2016).

Examining the UAD process, the conclusion can be drawn that UAD needs a new development approach. An approach that is focused on the increasing complexity of UAD through the integration of economic, social and environmental impacts that UAD has. This entails that UAD needs a multidisciplinary approach from early in the development process. Furthermore, the complexity of UAD is increasing through the number of and diversity of the stakeholders involved. The increasing number of diverse stakeholders has led to a broader range of, sometimes opposing, interests. UAD, therefore, needs to be seen as a network system in which actors are at first focused on their interests (Franzen, Hobma, de Jonge, & Wigmans, 2011).

Thus, CUAD means implementing CE in built environment strategies in UAD processes. CE in the built environment can be described by both the circular construction processes of Platform CB'23 and the strategies of the ReSOLVE framework of the EMF. This research analyses the strategies through the analytical framework. The analytical framework is developed based on the ReSOLVE framework, the traditional and more modern UAD development processes and the characteristics of the circular construction process. The analytical framework is visualized by Table 2.

ANALYTICAL FRAMEWORK

The objective of the analytical framework is to discover what CUAD is by combining ReSOLVE strategies, the traditional and more modern UAD development processes elements and characteristics of circular construction. Traditional UAD processes consist of five elements: context, content, process, actors and policy documents. This research is focused on the development process of CUAD and is therefore mainly

focused on strategies concerning the process and the actors involved. However, the content or technical aspects of CUAD cannot wholly be neglected and are, therefore included in the analytical framework. Furthermore, literature has indicated the importance of context for (C)UAD. The element of policy documents has been left out in the analytical framework because policy documents are seen as instruments instead of strategies (Howlett, 1991).

The analytical framework for analysing the case studies is shown in Table 2. The rows indicate the different elements which are taken into account for the process of CUAD. The columns are related to the CUAD strategy. This strategy belongs to one of the ReSOLVE strategies and is only focused on the construction sector (CE 100 network, 2016). For example, share strategies for the actor element can entail strategies as co-housing, office-sharing or residential-sharing. An elaborated description of the analytical framework and the circular strategies can be found in Appendix A4.

2.4.2 Conditions for the process strategy for the transition to CUAD

This research has developed an own definition of CUAD since a clear definition or description is still missing in the literature. Moreover, an example of a successful process of CUAD is hard to find. Nevertheless, various drivers and barriers can be distinguished from the literature, which can be translated into conditions for the process strategy for the transition to CUAD. The main conditions found through the literature study for the process of CUAD are a multidisciplinary approach, considering different levels of implementation (macro-level and meso-level), the inclusion of context, a flexible process, speed in the process, an iterative process, openness/transparency, implementing ReSOLVE strategies and following the circular construction process. Next to the literature study, this research also focuses on what CUAD is in practice through case study research. The case study research analyses CUAD through interview questions which are based on the analytical framework.

TABLE 2- THE ANALYTICAL FRAMEWORK

	REGENERATE	SHARE	OPTIMISE	LOOP	VIRTUALISE	EXCHANGE
CONTEXT	LAW ON REUSE OF LAND		PROFITABLE BUSINESS SCENARIOS		OPEN DATA SOURCES	
CONTENT	LAND RESTORATION	PRODUCT AS SERVICE SYSTEM (PSS)	INDUSTRIAL PROCESS SMART URBAN DESIGN MATERIAL EFFICIENCY	OPTIMIZATION OF END-OF-LIFE OF THE BUILDING/MATERIALS MODULARITY OF THE BUILDING REMANUFACTURING OF MATERIALS	SMART APPLIANCES	
PROCESS		OPENNESS/ TRANSPARENCY	SPEED IN PROCESS FLEXIBLE PROCESS PROTECTION VALUES ACTORS	ITERATIVE PROCESS	VIRTUALISATION OF PROCESS	
ACTORS		CO-HOUSING OFFICE-SHARING RESIDENTIAL SHARING	VARIETY OF STAKEHOLDERS		TELEWORKING	NEW TYPE OF SERVICES
POLICY DOCUMENTS						

SOURCE: (OWN WORK)

3. METHODOLOGY

Source:(own work)

This Chapter focuses on the research approach that is followed to analyse the circular process strategy for the transition to CUAD. The research approach (Paragraph 3.1) consists of both desk research and field research. The two main objectives of the field research are the case studies and pilot study, which are described in Paragraph 3.2 and Paragraph 3.3.

3.1 RESEARCH APPROACH

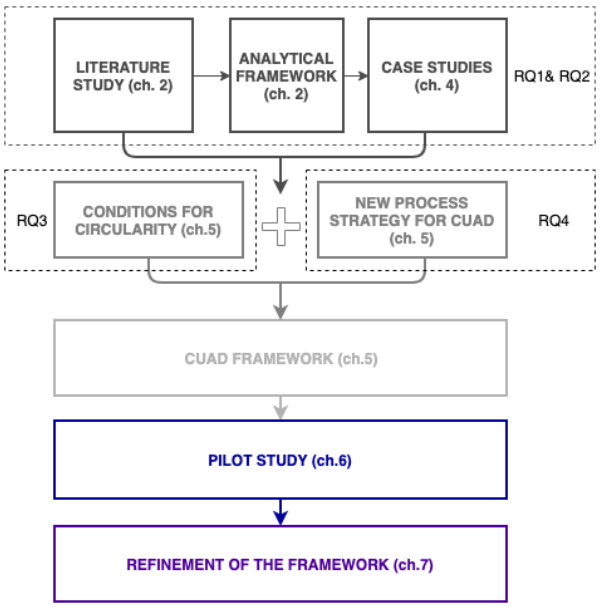
This research aims to examine and understand the process of CUAD to develop a process framework that facilitates the transition to CUAD for M4H. The objective of the study and the research questions imply explorative and qualitative research (Baxter & Jack, 2008). The study consists of three phases. The research approach and its phases are visualized by Figure 6.

The first phase is concerned with developing an analytical framework for CUAD. This phase consists of a literature study in which the concept of circularity in the built environment and the process of traditional urban area development are examined. The outcome of this analysis is the analytical framework. Next to the literature study, this phase consists also of fieldwork, which is done by explorative interviews, participating in various workshops and attending seminars. The explorative interviews, seminars and workshops are all focussed on implementing the principles of circular economy in the built environment, for example, the seminar of The Future of (no) Waste from Clean Tech Delta. An overview of the fieldwork done can be found in Appendix B1.1.

The second phase consists of fieldwork in which data is gathered through case study interviews. The case study interviews examine what CUAD is in practice, according to the analytical framework. Moreover, through the literature study and the cases study interviews, the conditions for the circular process strategy for the transition to CUAD are developed. The conditions for the circular process strategy for the transition to CUAD are henceforward defined as the conditions for circularity. Based on the conditions for circularity found through the research a suiting process strategy is chosen on which the process framework will be based on.

In the third phase, a pilot study concerned with parties involved in the development of M4H test the developed process framework. The process framework is then refined based on the outcome of the pilot study. The pilot study can be seen as the validation method for the process framework. Moreover, applying several research methods increases the validity of the research (Thabane, et al., 2010).

FIGURE 6- THE RESEARCH APPROACH



SOURCE: (OWN WORK)

3.1.1 PURPOSE OF THE CASE STUDY AND PILOT STUDY

Literature has indicated that CUAD needs a new process strategy for the development of urban areas (See Paragraph 2.5). Because CUAD is a complex and unknown phenomenon, both the case study and a pilot study (Yin R. , 2003).

CASE STUDY

The purpose of the case study research is to answer the question 'what is CUAD according to practice?' by examining the definition of CUAD and the strategies applied. The strategies applied in the cases are examined by means of the analytical framework developed in Chapter two. Next to the CUAD strategies, the conditions for circularity are distinguished from the lessons learned of the case study interviews. Moreover, the interview protocol of the case study interviews is also based on the analytical framework.

The outcome of the case studies is the input for the development of the process framework. The case study answers, therefore, indirectly how the process strategy for CUAD should be defined. Nonetheless, Yin (2003) argues that the case study method should be applied if the study is focused on "how" or "why" questions. The pilot study then tests the process framework.

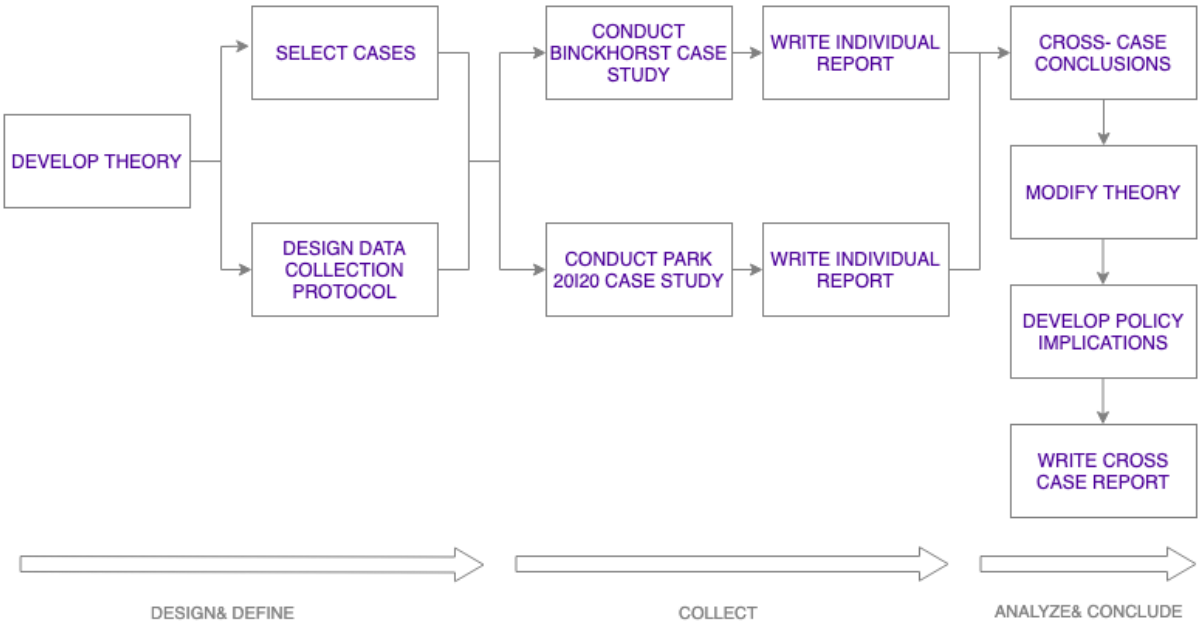
PILOT STUDY

Testing the framework developed by this research through a pilot study, or in other words by experimenting, fits perfectly to CUAD. Because the transition to CUAD is an ongoing learning process, according to the literature (Platform CB'23, 2019). Although a pilot study can test the objective of the pilot study. The research should not aim for generalisation of the findings of the pilot study but should aim for specification or optimisation of CUAD or the process framework (van Teijlingen & Hundley, 2001).

3.2 CASE STUDY DESIGN

Three phases often define a case study design. These three phases are the define and design phase, the prepare, collect and analyse phase and the analyse and conclude phase. Figure 7 displays the three phases and the different steps of the case study set-up.

FIGURE 7- CASE STUDY SET-UP



SOURCE: (YIN R. K., 2009)

PHASE I- DEFINE & DESIGN

The first phase is concerned with designing the case study protocol. Through the initial theory development, which is done by the literature study in Chapter two, cases are selected (Paragraph 3.2.1) and data collection protocols are made (Paragraph 3.2.2). The initial theory is interpreted and visualised by the analytical framework. The data collection protocol for the case study is based on the analytical framework and is translated into the interview protocol.

The objective of this research and the unit of analysis of the case studies is the process of redevelopment of urban areas. This process is focussed on the transition towards circularity in the built environment. Furthermore, this research examines two different cases concerned with circular urban area development and therefore applies the multiple case study approach. Multiple case study design has advantages because generally, the evidence created from multiple case studies is more robust and reliable than from a single case study. The cases that are examined are the redevelopment of Binckhorst in The Hague and Park 20I20 in Haarlemmermeer. Multiple case study research, however, is extremely time-consuming and can be expensive to conduct (Yin, 2011).

PHASE II - PREPARE, COLLECT AND ANALYSE

The second phase consists of two steps, conducting the actual case studies and developing the case study reports. The interviews are held in this phase, and the first analysis of the data is made. The first analysis consists of single case examination.

The data is collected through semi-structured interviews. The interview protocol describes the interview questions. See Appendix B2 for the interview protocol and the interview questions. The objective of the case study research is to examine what the concept of CUAD is in practice and what the conditions for circularity are according to practice. The concept entails the definition given and strategies applied. Each interviewee is asked for his or her definition of CUAD. The conditions for circularity are distinguished from the experiences of the interviewees or so-called lessons (to be) learned. A more elaborate description of data collection through the interviews can be found in Paragraph 3.2.2.

PHASE III- ANALYSE AND CONCLUDE

During the last phase of the case study research, the analyses of the single case studies are compared, and a cross-case analysis is made. The cross-case analyses the similarities and differences of the CUAD strategies applied, and the lessons (to be) learned from the two cases. However, the generalisation of case findings is generally limited. It is essential to identify the chain of evidence to make overall conclusions (Yin, 2011). The case study results are, therefore categorized according to the type of strategies applied and the type of lessons learned (Appendix C). The lessons learned distinguished form the cross-case analysis are translated into the conditions for circularity. Based on these conditions, the process strategy on which the process framework is based on is chosen. The process framework developed through this research is validated through the pilot study (Maxwell, 1996, p. 87).

3.2.1 Selection of the cases

Six potential cases for CUAD in the Netherlands have been analysed. Though CUAD case examples are hard to find because, for instance, most examples or pilots of circularity in the built environment are only focussed on circular buildings. The cases which are focussed on the area instead of single buildings are the development of Beurskwartier in Utrecht, Binckhorst in The Hague, Buiksloterham in Amsterdam, Kabeldistrict in Delft, Lincolnpark and Park 20I20 in Haarlemmermeer. From these six cases, two cases are selected for the case study research because these cases met the four selection criteria. The four selection criteria are displayed in Table 3 and are defined as followed:

The main focus is on the circular construction flow

CUAD can include all different types of circular flows, like waste, energy and water. This research is focused on the circular flow of building materials and the actors involved in the built environment.

Because previous research has shown that the construction sector has the most potential for the transition to CUAD for M4H (See Paragraph 1.2).

Redevelopment of an old industrial area

The cases selected for the case study research should entail the redevelopment of an old industrial area. Since the development of M4H also consists of the redevelopment of an old industrial harbour area.

Different levels of development

CUAD is related to different levels of development. The cases should, therefore, include both area development as the development of single buildings. The cases should incorporate both the so-called meso-and macro-level of the built environment (Pomponi & Moncaster, 2017).

Change in the urban development process

Based on the literature study (Paragraph 2.2), the assumption is made that CUAD requires a new process approach. The selection of the cases is therefore based on the changes made, or the intention to make changes, in the urban area development process.

TABLE 3- CASE STUDY SELECTION CRITERIA

CASES	SELECTION CRITERIA			
	Redevelopment of an old industrial area	The main focus on circular construction flow	Different levels of development	Change in the urban development process
Beurskwartier, Utrecht (marco.broekman & LINT, 2017)			X	X
Binckhorst, The Hague (Wijsmuller, 2018)	X	X	X	X
Buiksloterham, Amsterdam (Metabolic, Studioninedot, & DELVA Landscape Architects, 2019)	X		X	X
Kabeldistrict, Delft (de Wilde, 2019)	X		X	
Lincolnpark, Haarlemmermeer, (Gemeente Haarlemmermeer, 2018)			X	
Park 20I20, Haarlemmermeer (Agentschap NL, 2019)	X	X	X	X

SOURCE:(OWN WORK)

Based on the selection criteria, two cases for the case study research. These two cases are Binckhorst in The Hague and Park 20I20 in Haarlemmermeer. Binckhorst is chosen because first of all, Binckhorst is an old industrial area which will be redeveloped into a mixed-use area for small industries, offices and houses. Secondly, Circular the Hague has identified three circular opportunities for the Hague. Binckhorst has become the prime area for implementing and testing circularity in the built environment for building materials (Wijsmuller, 2018). Thirdly, the area development consists of both

area development as single building projects. And lastly, Binckhorst is the pilot for a new urban area development process, the Environmental and Planning Act (EPA) which is the "Omgevingswet" in Dutch. A more detailed description of what the EPA entails can be found in 4.1.1.

Park 20I20 is selected because first of all, Park 20I20 is developed on the brownfield site of the old Fokker Factory. Secondly, because the vision of Park 20I20 is in line with circular perspectives for building materials through the C2C theory. Thirdly, Park 20I20 is a mixed-use park in which offices, sports facilities and the hospitality industry come together (Park 20I20, 2019). Park 20I20 has a circular vision for the whole area, but the development also consists of single building projects. And lastly, through the (then) rather new concept of Cradle-to-cradle (C2C) new ways of collaborating in the UAD process have been adopted (Agentschap NL, 2019).

3.2.2 DATA COLLECTION

Most of the data collected from the case studies is done through in-depth semi-structured interviews (Meyers & Newman, 2007). The interview aims to have an informative conversation and should not be an interrogation. However, the interview needs to steer the conversation towards the process of CUAD: the elements of UAD and the ReSOLVE strategies applied.

The interview is one of the most applied tools for data gathering in qualitative research. Still, an interviewer or interviewee can be biased and therefore influence the reliability and validity of the research. A common bias is the respondent bias; does the interviewee answer the questions honestly or does he or she gives the preferred answers (Brinkmann, 2014)? Furthermore, an interviewer must learn from the people instead of studying the people (Spradley, 1979). Therefore, practice is needed for successful interviews. Through the duration and timing of this case study research, no time exists for practising the interviews.

Nonetheless, in his book *Qualitative research from start to finish,* Yin (2011) shows several ways to overcome these biases. For example, speaking in modest amounts and being non-directive gives the interviewee space and environment to talk. Yin describes six tips for these kinds of interviews (Yin, 2011). These six tips are speaking in modest amounts, being nondirective, staying neutral, maintaining rapport, using an interview protocol and analysing when interviewing. These are considered during the case study research.

Next to data gathering to interviews, background information on the cases is found by literature research through sources like newspaper articles, reports and websites.

INTERVIEWEES

Eleven stakeholders are approached for an interview to examine the transition to CUAD in practice. These stakeholders are from different types of parties involved in the development process. These stakeholders range from the architect to the contractor and the client. An overview of the interviewees, their roles and their companies can be found in Table 4.

In general, the interviews are the same for almost all interviewees and are based on the interview protocol. For each interview, an audio record exists, and a summary of the audio transcript is made. The interview protocol is developed based on the analytical framework and the literature study in general and can be found in Appendix B2. Not all interviews are based on this interview protocol; one exception exists. The interview with the manager of Delta Development Group is based on a prescribed interview. A prescribed is used due to time constraints of the interviewee. Moreover, research ethics have been incorporated in the case study by considering, among other things, confidentially and responsible publication. All interviewees have been asked if the interview could be recorded and if their name could be mentioned in the report.

TABLE 4- CASE STUDY PARTICIPANTS

	Function	Company	Date
BINCKHORST	Researcher	I'm Binck	31/07/19
	Lector	Hogeschool van Rotterdam	15/08/19
	Consultant	PERSC	01/08/19
		Municipality of The Hague	21/08/19
		Municipality of The Hague	25/07/19
	Developer	Local	13/08/10
PARK 20I20	Project manager	IBB Kondor	23/08/19
	Commissioner of the King (Alderman off Economics affairs)	Province of North- Holland (Municipality of Haarlemmermeer)	28/08/19
	Architect	N30 Architects	28/08/19
	Develop manager	Reggeborgh Group	26/08/19
	Manager	Delta Development Group	19/08/19

SOURCE:(OWN WORK)

3.3 PILOT STUDY

The pilot study consists of a real-life small urban development experiment. Several aspects must be considered when designing a pilot study. These factors are the objective of the study, the sample size, and the feasibility criteria (Thabane, et al., 2010). Through the pilot study, the process framework is tested. However, the pilot study self has to be validated too.

3.3.1 PILOT STUDY FACTORS

OBJECTIVE

The purpose of the pilot study is to examine if CUAD of M4H can be facilitated through the process framework developed in this research. The general focus of the pilot is examination and learning by doing. From the objectives of the PoR authority, the explorative interviews and the literature research, it is preferable to start small but keep the possibility to scale up. Furthermore, CUAD principles entail that the subject and objective of the pilot study should be context-specific.

SAMPLE SIZE

The sample size entails specifications for the project like the subject, the project phase and the actors involved. Most UAD processes start with a master plan. Currently, the master plan for the Galilei Park in M4H is developed. This is, therefore, the subject of the pilot study. The objective of the pilot study is to incorporate CUAD strategies in the master plan. Moreover, the sample size includes the actors involved. From the literature study, the conclusion can be drawn that all actors involved during the whole life cycle of the project must be involved. For the pilot study, the client, the developer, the architect, and (environmental) consultant and the engineer have been involved. In total have six people participated in the pilot. The participants of the pilot can be found in Appendix E1.

FEASIBILITY CRITERIA

The feasibility criteria determine the success of a pilot study. Through the objectives of the pilot, the feasibility criteria are developed. The objective of the pilot study is to examine if the process framework could facilitate the transition to CUAD in M4H. Therefore, the feasibility criteria can be categorized in criteria related to testing the transition to CUAD and criteria which test the to the process framework. The CUAD feasibility criteria measure the success of the pilot while the framework criteria measure the success of the process framework. The feasibility criteria are described in Table 5.

3.3.2 VALIDATION OF THE PROCESS FRAMEWORK

The validation of the process framework is done through feasibility criteria related to the process framework. The process framework is validated by asking the client questions concerning the outcome of the pilot (Maxwell, 1996). These questions are related to relevance, usefulness and current and future value of the process framework. The questions related to feasibility criteria can be found in Appendix E2.

Testing the process framework by respondent validation has its pitfalls. For instance, responding to or evaluating an activity in which a person has been involved can lead to partial viewing (Torrance, 2012). Furthermore, Fielding and Fielding (1986) argue that participants can influence each other thoughts, and some individuals shape more the collective view than others. This is, therefore considered by individually approach the participants of the pilot study to validate the framework and the pilot study (Fielding & Fielding, 1986). The feasibility criteria are shown in Table 5.

TABLE 5- PILOT STUDY FEASIBILITY CRITERIA

FEASIBILITY CRITERIA	DEFINITION	MEASURING UNITS
CUAD		
CONCEPT	Consider the whole project life cycle at the start of the project	Is an actor overview at the start of the project made? Yes/No
OUTCOME	Choose circular strategy with highest circular impact. The pilot study should be developed further/ adapted.	- Range of 10r framework Should be between 0r-4r (of the 10r framework) - Does a follow-up exist: Yes/No
PROCESS	The process should contain the learning aspect	Feedback moments should be incorporated into the process. At least two.
ACTORS	The project team should contain the perspective of different disciplines	The (whole) project team should contain at least three team members with different expertise.
FRAMEWORK		
INCREASED KNOWLEDGE	The participants should understand the process	Participants answer more than half of the evaluation questions related to the process framework right.
POSITIVE FEEDBACK	The new process framework is positively experienced, and participants find applying the framework relevant.	The overall pilot should be evaluated as more than satisfactory (an average grade of 7 or higher on a scale from 1 to 10). The new way of working should be evaluated more than satisfactory (Erasmus University Rotterdam, 2019)
FOLLOW UP	The process framework will be applied in more (circular) urban development projects	Yes/No

SOURCE:(OWN WORK)

4. CASE STUDY RESULTS

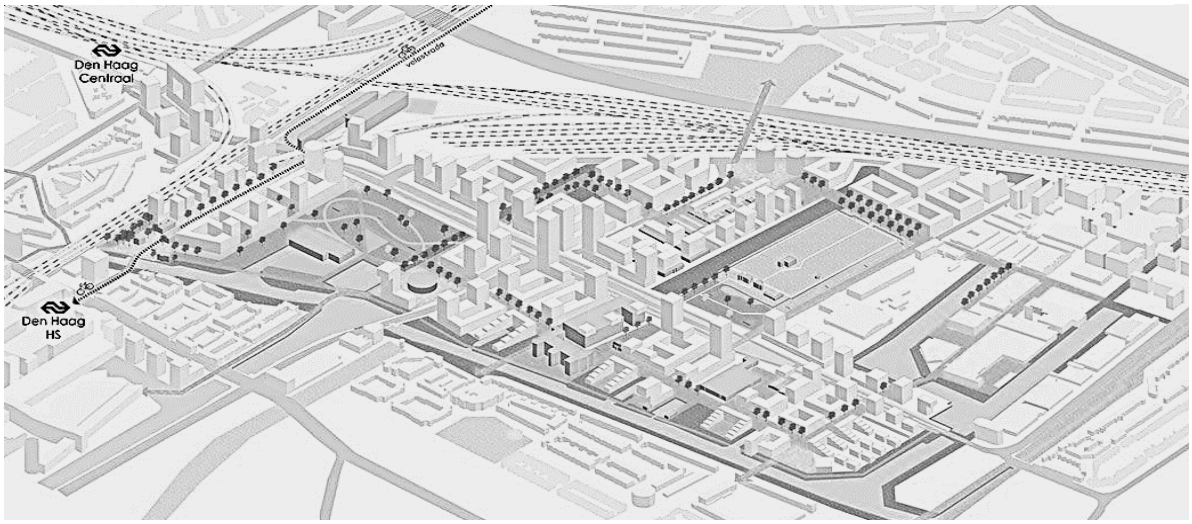
Source: (own work)

The goal of the case study research is to analyse how the transition to CUAD in practice. The case study research aims to analyse CUAD through the concept of CUAD: how do the actors within the projects define CUAD, and which circular strategies are applied? The concept of CUAD is derived from the cases studies, which are based on the analytical framework, as shown in Table 2 of chapter two. Next to the concept of CUAD, the experiences from the cases study interviews are translated in the lessons (to be) learned for each case.

The case study research is described by a short introduction of each case after which the results for the single case studies are presented. Paragraph 4.1 describes Binckhorst case and Paragraph 4.2, the Park 20I20 case. After the description of the single case studies, Paragraph 4.3 elaborates on the cross-case analysis. The last Paragraph (4.4) wraps up this Chapter with the conclusion of the case study research.

4.1 BINCKHORST

FIGURE 8- THE BINCKHORST



SOURCE: (POSAD, 2019)

4.1.1 INTRODUCTION

At the beginning of the 20th century, Binckhorst was still a polder district. Since 1900 Binckhorst transformed into an industrial area with the construction of the gas factory (1905) at the Trekvlietplein. Since then, it functioned as an urban industrial area with three harbours (Deelman, 1942). Currently, Binckhorst is known for its small industrial activities, like a stationery factory and a concrete/asphalt plant. The municipality of The Hague decided to fulfil the increasing demand for housing while maintaining Binckhorst as an industrial area (Stichting Haags Industrieel Erfgoed, 2017). The location of the area close to the city centre, the highway and train stations, has led to the decision that it should become available for both work activities and residential purposes (Gemeente Den Haag, BVR, & BGSV, 2005). Figure 8 illustrates the location of Binckhorst artistically.

One of the main objectives of the redevelopment of Binckhorst is that the area should become a driver of the economy of The Hague. This will be achieved through the four pillars of area development. The first pillar is that Binckhorst should increase employment at all levels of society: young and older inhabitants, with lower and higher education. This entails that Binckhorst will have a mix of new and existing economic activities. Binckhorst has to become a place for small local craftsmen, like confectionaries but also a district for startups to sprout and grow (Bart, 2018). Secondly, the district actively tries to attract startups. Thirdly, Binckhorst wants to keep its raw and industrial character. And lastly, the development of Binckhorst does not go according to a zoning plan, which can be seen as a blueprint. Because of the status of Binckhorst as a pilot project for the new

Environmental and Planning Act (EPA) the development of the area will be more organic than in traditional projects (Revis, 2019).

URBAN AREA DEVELOPMENT

The urban area development process of Binckhorst is different in comparison with the traditional urban area development process because of three reasons. Firstly, the process of developing the area is meant to be organic, following the principles of the new Environmental Planning Act (EPA). The EPA implies organic urban area development, in which the users and inhabitants of the area become the responsible party for the process of development (Rauws, 2016). Furthermore, the municipality has a facilitating role instead of a steering role in the development of Binckhorst. And lastly, the market is actively engaged (Gemeente Den Haag, 2019).

The EPA is a new legal framework for area development and replaces the zoning plan. Traditionally a zoning plan is established by the municipality. The zoning plan specifies the use of the land and buildings in particular areas. The EPA is introduced because experience has shown that the same legally binding frameworks for all area development projects in the Netherlands do not suit complex regional planning. Challenges such as the transformation of inner-city industrial areas to mixed-use zones. Legal frameworks should be adaptable to context-specific variables.

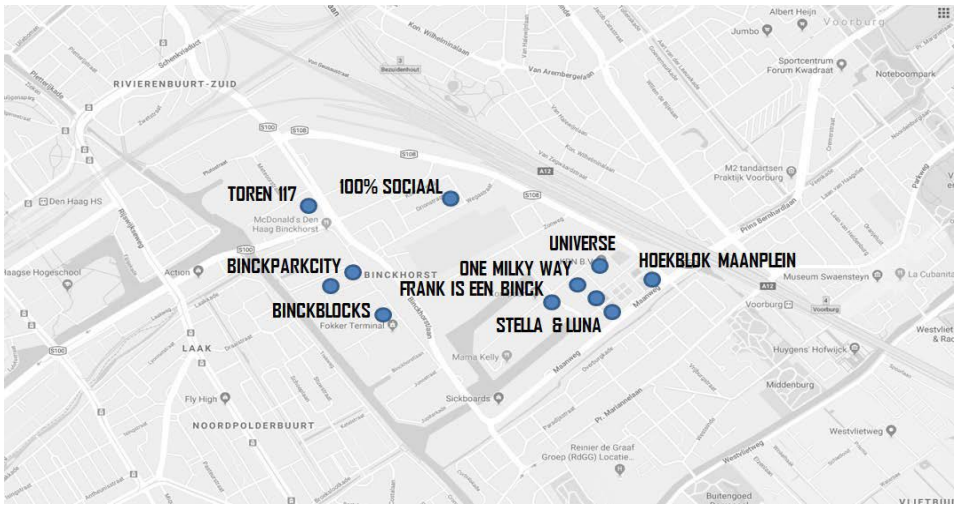
Furthermore, traditional urban area planning processes consist of various nationwide rules, regulations and plans. The EPA, on the other hand, aims to adopt a process to its specific context (Revis & Wijsmuller, 2015). The EPA simplifies legal regulations concerned with the development and maintenance of the built environment by integrating the 26 built environment laws into one general law. Moreover, the EPA leaves room for public bodies to steer the built environmental policy according to their interests and objectives. Lastly, the EPA creates more room for the ideas of market parties (Rijksoverheid, 2019).

ACTORS

The municipality of The Hague worked together with entrepreneurs, owners, network organizations, developers and inhabitants to develop a shared vision and goal for the district. Table 6 displays the different actors who are already established in the area. Figure 9 displays Binckhorst and the actors who already have been promised a permit to develop (Revis, 2019).

The EPA has been agreed upon by the local council of The Hague in March 2019, and since then Binckhorst is open for permit requests. Through the new reservation system, all actors can request housing permits for lots to build houses even if all lots are already reserved. Because of this system, more than 7000 housing permits have been requested in the first half-year of 2019 for only 5000 available houses.

FIGURE 9- RESERVED BUILDING LOTS BINCKHORST



SOURCE: (REVIS, 2019)

TABLE 6- THE CURRENTLY INVOLVED STAKEHOLDERS OF THE DEVELOPMENT OF BINCKHORST

ROLE	COMPANIES
MUNICIPALITY	Municipality of The Hague: Department of urban development
DEVELOPERS	Local
(We Think Binck: Stadmakers)	Stebru
	BPD
	Vorm
	De Mannen van Schuim
	Schouten
	Borghese Real Estate
	De OudendalGroep
ENTREPRENEURS	I'm Binck
HOUSING CORPORATION	Staedion

SOURCE: (REVIS, 2019)

THE OBJECTIVE ON CUAD

For the development of Binckhorst four ambitions are defined: accessibility, an industrial living and working environment, becoming one of the economic drivers and the pilot for sustainability for The Hague (Revis, 2019). The municipality of The Hague, therefore, sees the transition towards a circular economy as a way to increase sustainability. Spatial quality policies include sustainability and circular urban development through "Rules of the game". These form not directly legislation but indicate how the formulated ambitions can be reached. In Dutch, it is called "Spelregels die houvast bieden". The following rules of the game are written down in Chapter 2.3 of "Omgevingseffect Rapportage" (Gemeente Den Haag, 2018). The general impression of the area should be, according to this document:

- Industrial character
- Robust and attractive public spaces
- The density of an urban area (urbanity) and urban quality
- Clear and meaningful structures
- Sustainability (CO2 neutral, climate adaptive, nature-inclusive and circular).

4.1.2 THE CONCEPT OF CUAD FOR BINCKHORST

The concept of CUAD for Binckhorst is developed through the case study research by the definitions given, and the circular process strategies applied. Six participants from five different actors concerned with the development of Binckhorst were interviewed. The participants of the case study of Binckhorst can be found in Table 4 in Chapter three.

THE DEFINITION OF CUAD AS DEFINED BY BINCKHORST

Although CUAD is seen as an overarching concept, interviewees appear to have different perspectives on what CUAD entails in detail. For instance, some interviewees focus on the flow of materials while with others, the focus is on the adaptability of the development (Corbet, consultant, PERSC 2019). This difference confirms the claim from the literature; there is no one clear definition of what CUAD is (Kirchherr, Reike, & Hekkert, 2017). The results of the case study show further that the definition of CUAD formulated by the interviewees includes not only material flows, but all kinds of flows. Sharing knowledge and connecting people, for example, are also a part of CUAD. There was an agreement among interviews that, CUAD has to do with fit for purpose, which means that it should be constructed for its function. This was explained as followed by one actor" Why *use materials that will not last long if the outdoor space is designed for 100 years"*(Boswinkel, Developer, Local,2019). Furthermore, an area should adopt "easily" to the needs of future inhabitants or users. *"A district or city should always*

be able to be used, area development should, therefore, fit current needs but also future needs. CUAD is, therefore defined as an adaptable area that can easily meet the changing demands" (Verbeek, Project manager, municipality of The Hague, 2019).

STRATEGIES APPLIED IN THE DEVELOPMENT OF BINCKHORST

The results of the strategies applied from the analytical framework are examined according to the six ReSOLVE strategies. The results show that only one circular strategy is related to *Regenerate*, through the objective for decreasing energy use through hot/cold storage. Various strategies, on the other hand, are related to the *Share* strategy, which is the participation agreement, shared facilities Binck Blocks, the Wijksafari, the ronde tafel, first date(s), We think Binck. These are all strategies to include stakeholders in the development process. Looking at the *Optimise* strategy, four strategies can be distinguished: CO2 emission regulations, the BetonAkkoord, smart urban design and linking people, knowledge and networks (I'm Binck). For the *Loop* strategy, four strategies can be found the reuse of buildings, water fences, hub materials and revaluation milestones. No circular strategies of Binckhorst are related to the *Virtualise* strategy, and only one strategy can be found from the *Exchange* strategy, the EPA pilot. Appendix C1.1 shows how the strategies of the analytical framework are applied in Binckhorst.

Analysing the results of the current circular strategies that are applied in Binckhorst various statements can be made. First of all, various strategies have not yet been applied; however, the intention exists like transforming the water basin into a hot/cold storage. Secondly, most circular process strategies are focused on the Share strategy of the EMF's ReSOLVE framework. A third comment that can be made is that most strategies are related to the element of actors from the analytical framework (Table 2). Take, for example, the Wijksafari. The Wijksafari is an initiative from I'm Binck. "*The Wijksafari is a work form to show what is happening in a neighbourhood. The Wijksafari is not a marketing or promotion trick. By visiting the people who really know what is going on in the neighbourhood, such as the neighbourhood police officer, a resident or someone from a housing corporation, a representative image can be developed"* (Heijkers, Researcher, I'm Binck, 2019). The last comments are related to the process element. An essential aspect of the transition to CUAD is the process of CUAD. The process strategies that are applied are mainly related to communication and knowledge sharing. The development process of Binckhorst case can be described as open and transparent. The municipality, for example, has adopted the participation agreement. Through the participation agreement inhabitants should be consulted about new developments in the area (Gemeente Den Haag, 2019). Furthermore, one of the most innovative process changes applied in Binckhorst is its status as a pilot project for the EPA. The EPA aims to increase multidisciplinary participation and increase flexibility by decreasing the number of laws.

4.1.3 LESSONS LEARNED FROM BINCKHORST

Through the interviews, several lessons (to be) learned can be identified for the transition to CUAD for Binckhorst. From the interviews, both the positive and negative experience is translated into lessons (to be) learned. The lessons (to be) learned can be categorized in 'process', 'content' and 'context' aspects of CUAD and lessons learned related to 'actors' from the analytical framework.

CONTENT, CONTEXT AND PROCESS

When asked about the experience, three essential results come forward from the interviewees of Binckhorst. The first comment is concerned with the approach. More than a third of the lessons (to be) learned distinguished from the interviews are focused on the political or policy implementations of CUAD (Appendix C1.2). For example, the participation agreement increases knowledge sharing and transparency, which could be beneficial for CUAD. The second comment that was often made during the interviews is the importance to create incentives for CUAD through profitable business models. However, this is often still not possible through the lack of scaling.

Despite the objectives of the EPA to create a transparent process, numerous challenges related to the process of CUAD can be found. An example of a negative lesson learned from the EPA pilot is the implementation of the reservation system, which is part of the EPA pilot. The reservation system entails that the developer is held responsible for his s responsible for conducting his own environmental research on for example noise nuisance. This has not been the case in the past.

This has led to another challenge in the transition to CUAD for Binckhorst: trust between the market actors and the municipality. In the case of the EPA, the municipality should transfer a part of their responsibilities to the market. Various actors however pointed at a lack of trust between municipality and market. Trust is lacking through the fact that project developers are often seen as "*fast money-making companie*s' (Verbeek, project manager, municipality of the Hague, 2019; Boswinkel, Developer, Local, 2019). Furthermore, the development of Binckhorst is done by an experiment with EPA. The results of several interviews have indicated that EPA causes various problems since the EPA is not as flexible as it seems. "*Despite that, the number of rules and regulations are decreasing, the number of policies, on the other hand, has grown*" (Verbeek, project manager, municipality of the Hague, 2019).

THE ACTORS

One of the comments that are mentioned by all interviewees is focused on knowledge, or rather the lack of knowledge. The lack of knowledge can be classified into two categories: technical knowledge and managerial knowledge. Technical knowledge is knowledge about the use or reuse of materials or knowledge about new systems related to CUAD. Managerial knowledge is related to the lack of sharing knowledge (between departments of the municipality) and with a lack of knowledge of the "circular" activities in Binckhorst. Various small businesses are consciously or unconsciously dealing with "circular activities". Circular activities can be seen as activities or strategies that fit in the analytical framework. Unfortunately, no common platform or overview exists of all these kinds of activities. Appendix C1.2 describes the lessons (to be) learned for the transition to CUAD of Binckhorst.

A large number of comments was related to the actors concerned with the development of Binckhorst (Verbeek, Project manager, municipality of the Hague, 2019; ,Boswinkel, Developer, Local, 2019 ; Heijkers, Researcher, I'm Binck, 2019). A strong agreement among the actors exists that for the transition to CUAD of Binckhorst, the roles and responsibilities have to change to fit the CUAD processes. Looking at the roles and responsibilities of the development of Binckhorst the conclusion can be drawn that most of the responsibilities lay with the municipality and the developers. A consultant or architect, for example, can develop an idea but the real change occurs through the decisions of the developer: "*The project developer is, in the end, the one who ultimately has to opt for circularity*" (Corbet, Consultant, PERSC, 2019). However, the municipality can lay down the ground rules in which the developer makes his decisions. It is therefore important that the municipality steers on quality through rules and regulations, but also creates a vision together with the developers in an early phase. The reason is that it is rather challenging to implement CUAD at a later stage.

An example is the Binck Blocks, technically and legally, it is currently not possible to build a 115 m high building from reused materials. With a predetermined vision in which reused materials have to be applied, another type of building probably would have been designed. The roles and responsibilities for Binckhorst gathered through the interviews are shown in Table 7. Most roles and responsibilities distinguished from the case study are not solely applicable to CUAD but can fit other urban development issues like sustainable urban development, for example too. Like for example, the responsibility of the municipality to initiate (CUAD) vision development (Geissdoerfer, Savaget, Bocken, & Hultink, 2017; Leising, Quist, & Bocken, 2018)?

TABLE 7- ROLES& RESPONSIBILITIES OF THE INVOLVED ACTORS IN THE TRANSITION TO CUAD OF BINCKHORST

ROLES	RESPONSIBILITIES
MUNICIPALITY	Rules & regulations for quality and innovations Creating incentives for the market but keep own public responsibilities CUAD criteria in tenders Implementation of the participation agreement Vision development (with developers) Find parties for middle term (operators) Stimulating/facilitating information sharing Increase knowledge about CUAD Increase communication between own departments
PROJECT DEVELOPER	Initiation CUAD Encourage need for CUAD Creating trust with the municipality Including operators in project development Include the parties that are relevant for the whole project cycle Project analysis concerning the whole life cycle and parties involved Creating a shared vision Changing mindset quality before fast money Find parties for middle term (30 years)/ operators Communication with the departments of the municipality
MAIN CONTRACTOR	Scalable incentives CUAD Increasing the number of recycled materials
ARCHITECT	
SUPPLIER	
SUBCONTRACTOR	

SOURCE: (OWN WORK)

4.1.4 CONCLUSION BINCKHORST ANALYSIS

Examining the concept of CUAD and the lessons learned from Binckhorst interviewees the conclusion can be drawn that CUAD can be described as the coupling of all types of flows and that the process of CUAD should be adaptable. Secondly, examining the lessons learned related to the content, context and process, the conclusion can be drawn that one of the challenges is that the CUAD vision has not been incorporated from the beginning. It is rather challenging to incorporate CUAD vision after the design is already made. A condition for CUAD should, therefore, be that CE principles or visions should be thought of beforehand. A third comment that can be made is concerned with the EPA pilot. The status as an EPA pilot project makes implementing CUAD more difficult (Verbeek, Project manager, municipality of The Hague, 2019), even though the EPA theoretically suits CUAD. Transition to CUAD entails new ways of working, while the EPA pilot does the same but not always in the same way. It shows that the goal to have less strict planning regulations can lead to new planning policies that sometimes conflict. Another lesson to be learned is related to the need for profitable business models. CUAD will be attractive if the transition leads to profitable business models

Next to, Experience has shown that trust between market and municipality has to be created first before 'radical' changes in CUAD can occur. The transition to CUAD should, therefore, occur incremental. Moreover, Binckhorst case shows the importance of sharing knowledge and transparency between actors. The last lesson learned from Binckhorst is related to the roles and responsibilities. The most active players of the initiation and the transition of CUAD are the municipality and developers. The municipality and the developers should, therefore, initiate the transition to CUAD for Binckhorst.

The following conclusions can be drawn from the analysis of Binckhorst. Firstly, CUAD can be described as the coupling of all types of flows and secondly the process of CUAD should be adaptable.

Thirdly, examining the lessons learned related to the content, context and process, the conclusion can be drawn that one of the challenges for implementing CUAD in the development of Binckhorst is that circularity has not been incorporated in the vision from the beginning. Take, for example, Binck Blocks. It is challenging to incorporate a CUAD vision after the tender is set out. A condition for CUAD should, therefore, be that CE principles should be thought of throughout the initiation phase for them to be embedded within the vision. A third comment that can be made is concerned with the EPA pilot, the pilot of the EPA makes implementing CUAD more difficult (Verbeek, Project manager, municipality of The Hague, 2019), despite the fact that the EPA theoretically suits CUAD. Transition to CUAD entails new ways of working which the EPA in principle offers. Another lesson to be learned is related to the need for profitable business models. CUAD will be attractive if the transition leads to profitable business models

Next, experience has shown that trust between market and municipality has to be created first before a 'radical' transition to CUAD can occur. The transition to CUAD should, therefore, occur incrementally. Moreover, Binckhorst case shows the importance of sharing knowledge and transparency between actors. The last lesson learned from Binckhorst is related to the roles and responsibilities. The most active players of the initiation and the transition of CUAD are the municipality and developers. The municipality and the developers should, therefore, initiate the transition to CUAD for Binckhorst

4.2 PARK 20I20

FIGURE 10- PARK 20I20

SOURCE: (GEMEENTE HAARLEMMERMEER, 2019)

4.2.1 INTRODUCTION

Park20I20 is a centrally located business area in Beukenhorst-Zuid. Figure 10 displays Park 20I20. Beukenhorst-Zuid belongs to the municipality of Haarlemmermeer, an area that is created through the draining of the Haarlemmermeer in 1852 (Van Vuuren, 2019). Haarlemmermeer is mostly known for Schiphol, the largest airport in the Netherlands and also an important international hub.

Park20I20 is created by a consortium formed by Delta Development Group, VolkerWessels and Reggeborgh Group. In 2002 the partnership bought the land around the former aeroplane factory, the Fokker factory that had gone bankrupt. One of the many challenges of redeveloping this old industrial area was the enormous costs to clean and remove the contaminated soil. The high costs were then one of the reasons to start thinking about using used materials and renewable energy for the development of the area, according to Coert Zachariasse, CEO of Delta Development Group (Agentschap NL, 2019).

Park 20I20 subsequently formulated a shared ambition to become the world's first Cradle-to-Cradle (C2C) business park. The objective of Park 20I20 is to integrate sustainable buildings, an inspiring working environment and high-quality public spaces and facilities with the overarching

principle of putting people at the heart of each development (Park 20I20, 2019; Gemeente Haarlemmermeer, 2019).

URBAN AREA DEVELOPMENT

The high cost of redeveloping the old industrial area and the sustainable ambitions for the development has led to the cradle-to-cradle business park concept. The municipality of Haarlemmermeer has granted permission to Delta Development to develop the park in accordance with the traditional zoning plan. At the start of the construction in 2009, C2C was still a relatively unknown concept in the construction industry.

The building process of Park 20I20 is somewhat different compared to general construction projects at that time. Most contractors did not know the concept of C2C or had worked with C2C-products. The process of redeveloping Park 20I20 is, therefore, innovative through two aspects. First of all, the process of developing a C2C project was an experiment in itself. Suppliers were asked to experiment with C2C by developing products according to C2C principles. Secondly, in traditional construction projects, the project developer is not directly in contact with the supplier, which was indeed the case in Park 20I20 (Agentschap NL, 2019).

ACTORS

Park 20I20 is an entirely private initiative of Delta Development Group, VolkerWessels and Reggeborgh Group, who collaborated with the municipality and other involved stakeholders. Through the innovative character of the project, the collaboration between the project developer, architects and suppliers already existed in an early phase of the development process (Agentschap NL, 2019). Throughout the ten years of development of Park 20I20, the project team has not changed much. Only a few key actors have changed since the first building was developed in 2009. Park 20I20 follows a step-by-step development process, in which one or two buildings are constructed at the same time. This is in accordance with UAD, which consists of the development of several “small” projects such as the development of single buildings. The SHARE building is currently under construction.

The SHARE building is an example in which C2C and CUAD ideas are translated (IBB Kondor, 2019). It is designed as a multi-tenant user building which incorporates the shared usage of building facilities. Table 8 displays the actors involved in the development of the SHARE building in Park 20I20. The municipality is not actively involved anymore during the construction of the SHARE building but is displayed in Table 8. This because the municipality of Haarlemmermeer did have an essential role in the development of Park 20I20 as a whole.

TABLE 8- THE CURRENTLY INVOLVED STAKEHOLDERS IN THE DEVELOPMENT OF PARK20I20

ROLE	COMPANY
Municipality	Municipality Haarlemmermeer
Client	Park 20I20 MT C.V. Delta Development VolkerWessels Reggeborgh Group
Architect	William McDonough & Partners N30 Architects
Main contractor	IBB Kondor
Contractor- Builder	Van de Vorm Engineering

SOURCE: (IBB KONDOR, 2019)

OBJECTIVE CIRCULAR URBAN AREA DEVELOPMENT

The C2C concept implies that all buildings developed in Park 20I20 are seen as material storage units or hubs. After fulfilling their function in the office buildings, all building elements or building materials

should go back to the biological or technical cycle. The buildings constructed for Park 20I20 should therefore not generate any waste (Mak, 2013)

The C2C theory consists of three principles: everything is a nutrient for something else, use entirely renewable energy and enjoy diversity (McDonough & Braungart, 2002). These three principals have been translated into four guidelines for the development of Park 20I20 and are defined by the following principles.

- Design for dismantling
  Buildings have a high residual value at the end of their life and are able to reuse many components. Design for dismantling should increase the value of a building after it is used instead of decreasing the value.
- Productivity and Health
  Traditionally many buildings contain chemicals that can harm people and the environment. By using non-harmful materials, the productivity and health of the employees can be increased.
- Material passport
  Each building has its own material passport. A material passport contains what the residual value is of the building and its materials.
- Lease products
  Products used for construction are rented instead of bought.

Examining the theory of C2C and the principles of the circular economy, many similarities can be found. Nevertheless, when the concept of C2C for Park 20I20 was developed, the circular economy as it is defined today did not exist yet. C2C is often mentioned as a strategy or part of the whole circular economy approach (Mak, 2013). The definition of CE is – amongst other theories – based on the C2C concept.

4.2.2 The concept of CUAD for Park 20I20

Five different companies have been approached for the Park 20I20 case study. Each company has brought in one participant for this research. The participants, their companies, their function and the date of the interviews are shown in Table 4 in Chapter three.

Definition of CUAD as defined by the Park 20I20 case

The concept of CUAD is analysed by the definition of CUAD given and by the circular process strategies derived from the analytical framework. Next to CUAD, the results show the differences between C2C and CE. Some interviewees found the two concepts similar, while others found one being part of the other. One interviewee argued that both theories are just components of the sustainable way of working. The following definition has been given by one of the interviewees concerning the difference between CE and C2C*; "I think that CE and C2C are the same. However, if you look at building sustainably, that goes beyond the principles of CE or C2C*" (Rietberg, Project manager, IBB Kondor, 2019).

Strategies applied in the development of Park 20I20

The results of the strategies applied in the development of Park 20I20 are examined by the ReSOLVE strategies of the analytical framework (Chapter two). For each of the *Regenerate* and *Virtualise* strategies only one strategy has been applied, the water-cool system and implementation of BIM. Moreover, it can be noticed that the number of activities is almost equally divided between the strategies *Share, Optimise* and *Loop*. Examples of these strategies are respectively shared elevators, research into C2C materials, and the implementation of click bricks. The shared elevator in the development of Park 20I20 can be defined as PSS. Nonetheless, the elevators are not bought but rented: *The contractor has rented the elevators instead of buying them as assets. Maintenance is for the supplier Mitsubishi* (Kragtwijk, 2019; Agentschap NL, 2019). Lastly, two of the applied strategies are related to the *Exchange* strategy, which is the paid land reservation system and use of C2C materials. Appendix C2.1 describes in more detail the applied circular strategies for Park 20I20.

Various strategies for transforming materials and products to C2C certificated materials and products have been applied, although not all these strategies are conceptualized in the analytical framework. What can be noticed from the analytical framework is the focus on research into C2C and CUAD. Throughout the ten years of developing Park 20I20, CUAD is continuously optimised through research on C2C and experimenting with C2C.

4.2.3 Lessons (to be) learned from Park 20I20

The lessons (to be) learned from the development of Park 20I20 are derived from the interviews focussed on the circular process strategy defined by the analytical framework and can again be categorized by lessons (to be) learned related to content, context and process and to the lessons (to be) learned related to the actors involved and their roles and responsibilities.

CONTENT, CONTEXT AND PROCESS

The results of the interview lessons learned show first of all, despite the innovative and challenging character of Park 20I20 fewer negative experiences than positive experiences can be distinguished. For example, scenario analysis has shown a possible profit of C2C application, which has been indicated as an important driver for CUAD and through the years, the number of C2C certificated materials has grown. Moreover, the transition to CUAD for Park 20I20 is currently driven by, among other things, the incentive to build sustainable, a guiding vision, a 'spot on the horizon', early investments in spaces outside of the buildings and the inclusion of suppliers and contractors from the start. An elaborate description of the lessons learned from Park 20I20 can be found in Appendix C2.2.

THE ACTORS

Looking at the lessons learned related to the actors involved in the development of Park 20I2, most negative experiences come forward through the lack of knowledge of C2C materials and the practical application of C2C (Appendix C2.2). Lack of knowledge is seen as an essential challenge for the transition to CUAD by all interviewees of Park 20I20. Lack of knowledge is concerned again with both technical knowledge and managerial knowledge. Lack of technical knowledge in the case of Park 20I20 is related to the application of C2C materials, challenges that occur through uncertainties about costs and risks and through the fact that it is difficult to value the social benefits of constructing a C2C building (Zachariasse,Developer,Delta Development Group, 2019). A lack of managerial knowledge on the other hand is related to learning new ways of working but also to changes in politics. For construction projects, which take long to build, it is important to include politics. "*The increasing duration of building projects causes higher investment risks. Incremental investments are one way to respond to this increasing risk*" (Rietberg, Develop Manager, Reggeborgh Group 2019).

Nevertheless, from the results of the interviews, the conclusion can be drawn that the lack of knowledge about CUAD has decreased during the ten years of developing Park 20I20 through knowledge sharing and transparency. "*The number of projects that are focused on CE, C2C or CUAD can grow if a significant number of studies will be done* " (van Dijk, Commissioner of the King, Province of North-Holland, 2019). Moreover, throughout the ten years of developing Park 20I20, the leading project team has generally stayed the same. This continuous project team has increased the development of knowledge and information sharing.

The last comment that can be made concerning the lesson learned from the development of Park 20I20 is related to the changing roles and responsibilities of the parties involved. The C2C development method suggested new ways of working and changing roles and responsibilities. In traditional construction projects, the supplier is not involved at the beginning of the project while with the development of Park 20I20 suppliers where included or consulted at the start of the project. Furthermore, despite the fact that Park 20I20 is an entirely private initiative, the municipality has actively been involved in the development to guarantee quality through the Qteam. "*During the early stages of the development of Park 20I20, the project team had a meeting with the Qteam of the municipality every two weeks, while normally this meeting only occurs 2 times during the whole urban area development project"* (Grosfeld, Architect, N30 Architects, 2019). Table 9 displays the roles and responsibilities analysed in the case study of Park 20I20. Similar to the roles and responsibilities

distinguished in Binckhorst case, the roles and responsibilities examined for Park 20I20 can also be applicable for other urban development projects.

TABLE 9- ROLES& RESPONSIBILITIES OF THE INVOLVED ACTORS IN THE TRANSITION TO CUAD OF PARK 20I20

ROLES	RESPONSIBILITIES
MUNICIPALITY	• Zoning plans with programme of requirements • Decide upon the character for the area • Sustainability conditions (certifications) • Decide on land ownership • Incentives building sustainable • Decide focus points legal framework • Steering through Q-team • Active involvement • Linking CUAD knowledge • Linking techniques/ integration of market initiatives
PROJECT DEVELOPER(S)	• Initiation project • Analysing area & possibilities whole cycles project • General CUAD vision of project (aim high) • Set boundary conditions • First initiation project team • Interact with clients (workshops) • Create an integrated vision • Risk analysis & communication • Include politics • Creating trust
ENGINEER	• Anticipate future stages of the project
MAIN CONTRACTOR	• Anticipate future stages of the project • Include operators and subcontractors in the early phase
ARCHITECT	• Include CUAD in design • Interact with the client (workshops)
SUPPLIER	• Technical knowledge/skills • Innovate/ Experiment
SUBCONTRACTOR	• Technical knowledge/skills • Innovate/ Experiment

SOURCE: (OWN WORK)

4.2.4 CONCLUSION PARK 20I20 ANALYSIS

Analysing the concept of CUAD through the results of the case study, it can be noticed that knowledge about the concept of CUAD has increased during the construction of Park 20I20. Park 20I20 is in development for over ten years now. Throughout the years, the knowledge of C2C materials and expertise of C2C has grown. C2C can be defined as part of CE, CUAD or of sustainability.

Examining Park 20I20 through the lessons learned, the conclusion can be drawn that despite the innovative and experimental character, more positive than negative experiences have come forward from the interviews. C2C implementation has grown throughout the years by practical implementing through experimenting and research. Learning by doing and research into CUAD are, therefore, important conditions for CUAD. Furthermore, most negative lessons learned are related to a lack of knowledge. This lack of knowledge is mostly concerned with the knowledge of C2C or CUAD techniques. Nevertheless, a continuous project team has led to frequent information sharing and re-evaluations of the work. This enhances the learning process. Sharing information and knowledge is,

therefore seen as an essential condition to diminish the lack of knowledge. Lastly, from the roles and responsibilities, the conclusion can be drawn that the most active actors are the municipality and the developer. However, architects, contractors and suppliers have been involved early in the project. Including them at the beginning of the project can, therefore, be seen as important for the transition to CUAD.

4.3 CROSS CASE ANALYSIS

After the analysis of each case individually, a cross-case analysis of the two case studies is carried out. This analysis examines the similarities and differences found in the case study interviews. These similarities and differences are examined through the general differences in ambitions, the concept of CUAD and the lesson (to be) learned. The concept of CUAD is again determined by the definitions given, and the strategies applied. Furthermore, the lessons learned are transformed into the conditions for the circular process strategy for the transition to CUAD.

4.3.1 SIMILARITIES BETWEEN BINCKHORST & PARK 20I20

GENERAL

Binckhorst and Park 20I20 are both known as urban area development projects in which the aim to implement principles of the circular economy had a central position. Other urban area development projects that experiment with the implementation of CE do exist. However, the main focus of Binckhorst and Park 20I20 is on closing the loop of the construction flow, while other circular urban area pilots are more focused on other flows like energy and water, for example, Buiksloterham in Amsterdam (see Paragraph 3.2.1 of Chapter three). Furthermore, the case studies have both demonstrated that for the transition to CUAD, a guiding vision is highly recommended. Moreover, both developments are concerned with the redevelopment of old industrial area (See Paragraph 3.2.1).

THE CONCEPT OF CUAD

From the definitions of CUAD and the strategies applied, three conclusions can be drawn concerning the similarities of the cases. The first conclusion is related to the definitions given by the interviewees. Respondents of both Binckhorst and of Park 20I20 argue that CUAD is concerned with closing the loop of material flows and minimizing waste. The second conclusion is related to the circular process strategies. In both cases, the Share strategy from the ReSOLVE framework is the most applied strategy. Thirdly, in both cases, users were included in the development process. In the case of Binckhorst, the users are defined as the inhabitants and for Park 20I20 users are characterized by the companies that make use of the buildings.

THE LESSONS LEARNED FROM BOTH CASES

The lessons learned from the two cases can be classified into eight themes. These eight themes are profitable business, regulation, lack of knowledge, practical implementation, transition, actors, collaboration and vision of CUAD. Appendix C3.1 shows the lessons (to be) learned from each case categorized by the eight themes.

From these eight themes, two main conditions can be distinguished by comparison of the cases. Both cases demonstrate that knowledge sharing, and an experimental and incremental transition are important conditions for circularity. The development of Binckhorst shows that the new Environmental and Planning Act (EPA) and reservation system could work eventually, but both the market and the municipality need time to adjust to new regulatory frameworks. Small experimental steps, which can be translated into incremental experimentation, can help to create trust between the parties. For Park 20I20 this need for experimentation and the incremental transition is shown by the increase of knowledge about C2C application in each building and decreasing risk by incremental investments. Furthermore, the continuous project team of the development of Park 20I20 has led to knowledge sharing and transparency.

4.3.2 Differences between Binckhorst & Park 20|20

GENERAL

Binckhorst and Park 20|20 differ in several key elements. One of the first things that can be noticed is the fact that Park 20|20 is solely a private initiative while Binckhorst is developed by a collaboration of both the municipality and the market. Secondly, the target group the areas want to attract is different as well. Binckhorst wants to develop an area for both manufacturing companies and residential housing while Park 20|20 is only focused on office buildings and does not include residential buildings. The third difference is in the type of innovation approach in developing. In the case of Binckhorst, CUAD is stimulated by steering others to change business models. While the initiation to build Park 20|20 arose from the idea for a different type of development method and therefore, a different type of business model from the developer itself.

THE CONCEPT OF CUAD

Comparing Binckhorst and Park 20|20 on the concept of CUAD, two remarks can be made. Although in both cases, the interviewees gave diverse definitions, the definitions of the stakeholders could be distinguished by their focus on the urban area development scale. For the stakeholders of Binckhorst, the focus of the development scale of CUAD was related to area development, while the stakeholders of Park 20|20 generally defined CUAD on the scale of a single project. For example, an interviewee of Binckhorst emphasized the coupling of flows in his definition of CUAD, while interviewees from Park 20|20 were more focused on the reuse of materials (Heijkers, Researcher, I'm Binck, 2019; Kragtwijk, Project manager, IBB Kondor, 2019). The second difference between the concept of CUAD for Binckhorst and for Park 20|20 is concerned with the implementation of the circular process strategies. In Binckhorst, the focus is on communication and regulations, which can be seen as a theoretical approach to implementing CUAD. In the case of Park 20|20, the applied strategies are more practical. Here the strategies are concerned with experiments with the use of new materials and implementing virtual modelling software like BIM.

THE LESSONS LEARNED

Most lessons learned distinguished from the case study interviews of Binckhorst and Park 20|20 are similar and can be categorized by eight themes (See Paragraph 4.3.1). However, some distinctions can be made. First of all, the development of Park 20|20 focuses more on the substantive aspects, or technical aspects of the transitions to CUAD than the development of Binckhorst does. The transition to CUAD is focussed on experimenting with C2C materials and buildings while the development of Binckhorst is focussed on changing rules and regulations. When comparing the two other elements, process and actors, the conclusion can be drawn that Park 20|20 has a variety of factors that could stimulate the process of CUAD. While the process of CUAD in Binckhorst is somewhat obstructed due to already implemented EPA pilot. Lastly, if the actors are compared between the two cases, the conclusion can be drawn that for Binckhorst the lack of trust between the municipality and the market is a significant challenge. While Park 20|20, on the other hand, is concerned with a continuous project team that shares information and in which trust does not seem to be an issue.

4.4 CONCLUSION CASE STUDY ANALYSIS

The objective of the case research is to examine what CUAD is in practice and to examine the strategies that should be applied for the transition to CUAD. The development of Binckhorst and the development of Park 20|20 are examined based on the concept of CUAD and the lessons learned from each case. The analysis of the lessoned learned from the cross-case analysis is summarized and conclude into the conditions for the circular process strategy for the transition to CUAD, or the so-called the conditions for circularity.

THE CONCEPT OF CUAD

From the single and cross-case analysis, the following definition for CUAD is developed *"CUAD is a development process which entails various projects in which knowledge is created, and the lifecycle of*

a material, building or urban area is upfront taken into account". Moreover, the concept of CUAD can be examined through the strategies applied. Gaining knowledge and knowledge sharing is essential for newly developed methods like CUAD. Including clients and other stakeholders in the CUAD process is, therefore important. Furthermore, CUAD can be defined as experimentation and learning by doing.

CONDITIONS FOR CIRCULARITY FOUND THROUGH THE CASE STUDIES

From the lessons learned of the cross-case analysis, eight themes for the circular process strategy for the transition to CUAD are developed and translated into conditions for circularity. The conditions for circularity derived from the case studies are: profitable business scenarios, include politics, room for experimenting, incremental transition, guide development through regulations, variety of stakeholders, information/knowledge sharing, shared vision, guiding party, CUAD overview of the actors/activities and increasing technical knowledge.

The conditions are mostly related to managerial aspects of circular process strategy for the transition to CUAD. However, the case studies have shown the importance of technical and substantive aspects of the transition to CUAD like knowledge about the quality of materials. The condition of increasing technical knowledge includes these technical aspects. The definitions of the conditions for circularity developed through the case study research can be found in Appendix D1.2

5. THE CUAD FRAMEWORK

Source: (Own work)

The results of both the literature study and the case study are the basis for selecting the process strategy that fits the transition to CUAD. This Chapter will compare and discuss the conditions for circularity found in the literature study with the conditions found in the case studies. Based on these conditions, the last sub-question is answered in the second Paragraph by selecting the process development strategy that fits CUAD.

The first Paragraph (5.1) describes the analysis of both the literature study and case studies. The second Paragraph (5.2) describes the chosen process strategy and method. The Paragraph after that (5.3) describes how this method is transformed to fit into the CUAD process. The last Paragraph (5.4) wraps-up the Chapter by the conclusion.

5.1 LITERATURE STUDY VS CASE STUDY RESEARCH

The analysis of the literature study versus the case studies is focused on both the concept of CUAD and the conditions that need to be met by the framework to facilitate the transition to CUAD. The analysis of the concept of CUAD elaborates on the definitions given, and the strategies applied. The analysis concerned with the conditions for circularity examines what is needed for the transition to CUAD.

5.1.1 THE CONCEPT OF CUAD

The concept of CUAD consists of the definition, and the strategies applied. Not one universal definition of CUAD is given in the literature (Kirchherr, Reike, & Hekkert, 2017). This research, therefore, has followed the circular strategies of the ReSOLVE framework from the EMF and the concept of the circular construction process from Platform CB'23. The EMF is worldwide known and consulted about CE and Platform CB'23 is seen as the leading party for CE in the construction industry in the Netherlands. The definition found through the case studies will, therefore, be compared to the definition from the EMF for CE and the definition for the circular building process by Platform CB'23. Platform CB'23 defines the circular building process as "*An iterative and interactive process in which the building phases do not have a fixed beginning or end. Each phase of the circular building process influences the other phases. Stakeholders of the circular construction process should anticipate on the current and future stages of the process as much as possible*" (Platform CB'23, 2019).

The definitions found in the literature study and the case studies all focus on a closed or circular process. For the definition of CUAD for Binckhorst, it is said that "CUAD is concerned with linking flows. Not only material flows but also linking knowledge and people are a part of CUAD" (Heijkers, 2019). According to the case study of Park 20I20, CUAD can be defined as *"Choosing and using materials that have a residual value when you replace them. So, think upfront about what you (or someone else) do with it at the end"* (Kragtwijk, Project manager, IBB Kondor, 2019). The definition developed through the case studies takes people and knowledge into account, similar to the definition of the EMF, which is also focused on well-being through incorporating the benefits for society (MacArthur, 2013).

Next to the definition of CUAD, the concept of CUAD is also defined by the circular process strategies applied. Comparing the analytical framework with the applied circular process strategies, the conclusion can be drawn that the Share, Optimise and Loop strategies occur most often in both case studies. While Virtualise and Exchange strategies have been applied once or not even once in each case. The type of strategies described in the literature is related to the type of strategies applied in the cases. For example, an open and transparent process is translated in Binckhorst through strategies like the Wijksafari. The main contrast between literature and case study applied strategies can be found in the Optimise strategy concerned with the process element of the analytical framework and the Virtualize strategy (See Table 2 for the analytical framework with the ReSOLVE strategies and the UAD elements). The strategy Virtualize has only been applied to the development of Park 20I20 by the implementation of Building Information Modelling (BIM). Interviews have indicated optimisation of processes and materials is important; however, the Optimise strategy is yet not often applied to lack of knowledge or resources. Lastly, the strategy of speed in the process has not been mentioned as necessary by the interviewees.

5.1.2 CONDITIONS FOR CIRCULARITY

Next to the concept of CUAD, the conditions for circularity found through the literature study and case studies are examined on the similarities and differences. The literature study has indicated the need for a new process strategy for CUAD. This need is based on several studies into circularity of the built environment and the drivers and barriers of CE (Prendeville, Cherim, & Bocken, 2018; Pomponi & Moncaster, 2017; Tura, et al., 2019). This need is defined by several conditions that need to be met for the transition to CUAD. Looking at the outcome of the case studies, the lessons learned of both case studies are translated into the conditions for circularity found through practice.

Evaluating the similarities between the conditions found in the literature and the case studies the conclusion can be drawn that several lessons learned from the case studies are also described by the drivers and barriers for the transition to CE by Tura et al. (2019). For example, uncertainties concerning the costs and risks of adapting to CUAD and uncertainties about the potential benefits of CUAD are pointed out as important barriers in the literature study and as a negative lesson learned from the case study (Appendix A1). Furthermore, both the literature study and the case study have indicated an open collaboration and communication within the network as a driver for CUAD.

Analysing the differences between the conditions found through the literature study and through the case study, the assumption can be made that three main differences can be found regarding the conditions for circularity. First of all, a lack of social awareness is pointed out by Tura et al. as a barrier to the transition to CUAD (Tura, et al., 2019). While both results of Binckhorst case and Park 20I20 show that awareness about CUAD exists. Moreover, lack of awareness has not been mentioned as a challenge. Secondly, the literature has indicated the need for speed in the process of CUAD, while this condition has not come forward through the case studies. And thirdly, the level of implementation, such as a differentiation between the meso-level (building) and the macro-level (area), has not been mentioned in the case studies. While literature study has indicated the importance of differentiation between the meso-level and the macro-level for research into CUAD (Pomponi & Moncaster, 2017; Prendeville, Cherim, & Bocken, 2018).

5.1.3 CONCLUSION LITERATURE STUDY VS CASE STUDY RESEARCH

The literature study and case study results are analysed based on the concept of CUAD and the conditions that need to be met by the framework to facilitate the transition to CUAD. From the analysis concerned with the concept of CUAD, the conclusion can be drawn that CUAD it is still a relatively unknown concept, with general guidelines in which learning and sharing knowledge is of great importance. Moreover, the circular strategies displayed by the analytical framework are often applied in practice.

Examining the conditions found by literature study and the case studies the conclusion can be drawn that most conditions are quite similar. The conditions of both the literature study and the case studies are therefore categorized and grouped. For example, an important aspect, according to the literature, is the level of implementation: meso-level or macro-level. The level of implementation or the spatial aspect is mentioned in the literature but has not come forward as a condition for circularity by the case study research. The condition incorporating different levels is a sub-conditions of the main condition adaptable process. In total,13 main conditions for circularity from both the literature study results and the case study results are distinguished. The comparison of the conditions from the literature study and the case studies can be found in the Appendix D1.1. Table 10 displays the 13 main conditions and the sub-conditions for circularity developed through this research.

The objective of this research is to develop a tool or a framework that facilitates the transition to CUAD. From the analysis of both the literature and case studies, the conclusion is drawn that the conditions for circularity can be classified by three categories the process, the participants and the outcome. The process conditions are an adaptable process, an incremental transition, include politics and guiding the vision. The conditions that are related to the participants are transparency, a variety of involved stakeholders, CUAD (actors/activities) overview, and changing roles and responsibility. The last group of conditions can be classified as conditions related to the outcome, which are vision

development, profitable business scenarios, technical knowledge. The conditions which come forward most often in (both) the cases and literature are the main conditions: adaptable process, a wide variety of users/stakeholders and a common vision/ dot on the horizon.

TABLE 10- THE CONDITIONS FOR CIRCULARITY

MAIN CONDITION	*Sub- condition*
1. INCLUDE POLITICS	
2. VISION DEVELOPMENT	Dot on the horizon
	Incorporating the specific character of the area
	Initiation phase
3. ADAPTABLE PROCESS	Flexible
	Experimental
	Iterative and interactive
4. INCREMENTAL TRANSITION	
5. NEED FOR GUIDING	Inclusion of contextual aspects
	Need for guiding of the process
6. INFORMATION SHARING/ TRANSPARENCY	Need for guiding
	Continuous project team
	Communication (between departments)
7. VARIETY OF INVOLVED STAKEHOLDERS	Variety of perspectives
	Network environment
	Early involvement
8. CUAD (ACTIVITIES/ ACTORS) OVERVIEW	
9. INCLUSION OF CONTEXT ASPECTS	
10. CHANGING ROLES AND RESPONSIBILITIES	
11. PROFITABLE BUSINESS SCENARIOS	Scale
	Risk management
12. RESOLVE STRATEGIES	
13. TECHNICAL KNOWLEDGE	Materials
	Techniques

5.2 THE PROCESS FRAMEWORK

The objective of this research is to develop a process framework which facilitates the transition to CUAD. This tool or framework is based on existing process development strategies established through previous research and literature study.

This Paragraph (5.2) aims to develop a process framework for CUAD by adapting an existing methodology. Paragraph 5.21 describes the different development processes, and Paragraph 5.2.2 selects the most suiting process development strategy or methodology. Paragraph 5.2.3 elaborates on this methodology, and in section 5.2.4, the selected methodology is adapted to fit CUAD.

5.2.1 DEVELOPMENT APPROACH

CUAD is a process of developing an area. Various tools or frameworks have been created for development processes. These frameworks or tools can be categorized into organising tools and analytical tools. Analytical tools are based on quantitative data, which has not been collected through the case studies in this research. Organising tools are focused on guiding the transition through facilitating collaboration in a qualitative manner. The process framework for the transition to CUAD should indeed also facilitate or guide collaboration in the transition to CUAD (Baumann, Boons, & Bragdad, 2002). The findings of the case studies can be used to create an organising tool like a process map. A process map can guide the process of collaboration of CUAD. This research, however, is not solely focussed on collaboration within CUAD. Moreover, the field study (Appendix B1) and previous studies (Paragraph 1.2) have indicated the need for a more practical or hands-on approach. The development approach for CUAD must be practical and project-based. Two main project development approaches can be distinguished, the traditional development approach and the agile development approach.

TRADITIONAL DEVELOPMENT APPROACHES

The principles of the traditional project development approach were established in the 1950s (Spundak, 2014). The traditional project development approach is largely applied in the construction sector (Sonneveld, 2018). The general perspective of the traditional approach is that projects are predictable, linear and have clear boundary conditions. The traditional project approach argues that a rational and normative approach with detailed planning and scheduling will lead to project success (Owen, Koskela, Henrich, & Godinhoto, 2006; Sutherland & Schwaber, 2007). The two most known schools of thought from for development projects in the construction industry are the Project Management Body of Knowledge (PMBOK) and the Project in Controlled Environments version 2 (PRINCE 2). PBMBOK aims to define and standardize the use of different project development tools for the realization of the project, and PRINCE2 is focussed on the managerial, organisational and steering aspects of the project (Wideman, 2002).

The traditional project approach assumes robustness by arguing that methods and techniques can be applied universally. However, more and more practitioners have objected against the traditional approach and indicate that “one size does not fit all’. Reality has shown that difficulties occur when projects are isolated from their geographical and political context because changes in the environment do affect a project (Spundak, 2014). Through these objections to the traditional project approach and the increasing complexity and need for an innovative new project, approaches have been developed. The software industry, in particular, developed many of these new approaches. The software industry is changing rapidly and needs project development approaches that are easily adaptable to changes during the project life cycle.

THE AGILE PROJECT DEVELOPMENT APPROACH

The agile development approach differs with the traditional project development approach in embracing a dynamic environment. Furthermore, the agile approach acknowledges that it is impossible to create a detailed project plan at the beginning of a project. Despite the possible benefits of the agile approach for dynamic and complex sectors like the construction industry, the agile approach is still relatively unknown and therefore not widely used within this sector (Sonneveld, 2018).

Agile can be seen as an umbrella name for several development tools that imply flexibility, ensuring customer satisfaction and meeting business needs. The agile manifesto consists of four values that the authors believe should be the guidelines for software developers. The four values are focused on customer requirement and emphasize the need for adaptability (AgileAlliance, 2001). The values are:

- People and interactions over process & tools
- Software over documentation
- Customer collaboration over contract negotiation
- Responding to change over following plan

AGILE IN THE CONSTRUCTION SECTOR

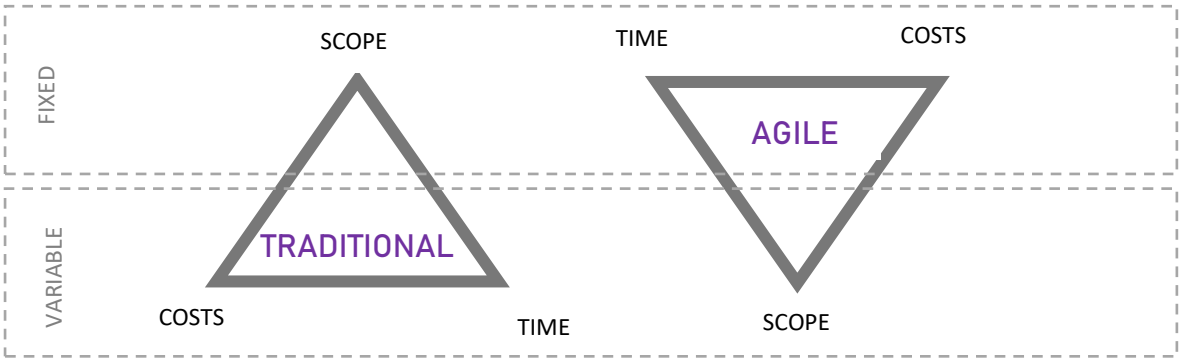
Even though agile is gaining popularity outside the software industry, the construction sector is still relatively unfamiliar with the approach. Nevertheless, some studies have shown the benefits of implementing a tailored, agile project development approach. The most common benefits of the agile approach compared to the traditional approach are the adaptability to change, the focus on solutions instead of detailed specifications upfront, initial values and short-term delivery, self-managing teams and close collaboration with the client (de Stoppelaar, 2017; Willams, 2005). The construction industry becomes more and more complex through, among other this, increasing environmental policies and an increasing number of actors. The increasing complexity and dynamic environment of the construction sector could benefit from an adaptable approach (Sonneveld, 2018).

Moreover, from the literature study and the case studies, the conclusion is drawn that the transition to CUAD is best facilitated through a flexible and adaptable approach. Nonetheless, the transition to CUAD has to deal with various uncertainties and risks due to the fact that CUAD is still a relatively unknown and undefined concept.

Comparing the agile methodology with traditional project development approach, the conclusion can be drawn that differences occur through the fact that the approaches have different focus points. The focus within the three main elements of project delivery - time, scope and costs - are different for the traditional project approach and the agile project approach. Figure 11 is a visual representation of the differences between the traditional project approach and the agile project approach. Figure 11 visualizes a fixed scope within the traditional approach, which can lead to, for example, a changing duration or changing costs of the project. In the agile approach, on the other hand, duration and costs are fixed, and adaptations are made to the scope of the project.

The assumption can, therefore, be made that the more adaptable agile project development approach might suit the transition to CUAD, therefore, better than the traditional development approach. This due to the fact that first of all, the agile approach emphasizes flexibility and adaptability through iterative development approach. Secondly, agile methodology can often manage uncertainties better than traditional approaches through the fact that the scope in agile projects is not fixed.

FIGURE 11- THE IRON TRIANGLE OF THE TRADITIONAL APPROACH VS THE AGILE APPROACH



SOURCE: (Ogunlana, 2010)

5.2.2 SELECTION OF THE METHOD

In this research, 13 main conditions for circularity are identified on which the process development method is selected. These 13 main conditions can be grouped in conditions related to the process, the participants and the outcome (See Paragraph 5.1.3). Based on these conditions concerned with the process, the participants and the outcome, an appropriate methodology for CUAD can be introduced, the scrum method. The scrum method is an agile development tool and can be defined as a development method that facilitates flexible and dynamic project development (Satpathy, 2013). Scrum entails working with a multidisciplinary team in short cycles. Furthermore, the scrum method does not define the outcome in detail upfront but has a vision for the development of the project, which is followed through the project requirements. Next to this, eight of the thirteen main CUAD conditions can be found in the scrum method. Table 11 displays the conditions for circularity which are directly met by the scrum method and the conditions which are not directly met.

TABLE 11- CONDITIONS FOR CIRCULARITY INCLUDED IN THE SCRUM METHOD

CONDITIONS FOR CIRCULARITY	
conditions which are met by the scrum method	*conditions which are not met by the scrum method*
2. VISION DEVELOPMENT	1.INCLUDE POLITICS
3. ADAPTABLE PROCESS	8.CUAD OVERVIEW
4. INCREMENTAL TRANSITION	9. INCLUSION OF CONTEXT
5. NEED FOR GUIDING	12.RESOLVE STRATEGIES
6. INFORMATION SHARING/ TRANSPARENCY	13.TECHNICAL KNOWLEDGE
7.VARIETY OF INVOLVED STAKEHOLDERS	
10.CHANGING ROLES AND RESPONSIBILITIES	
11.PROFITABLE BUSINESS SCENARIOS	

SOURCE: (OWN WORK)

First of all, in scrum projects, the outcome of the project is not upfront decided upon, but a vision is made through the product requirements. The project is developed step by step through the sprints. Secondly, scrum projects are developed during iterative sprints. Through these iterative sprints, the project is revised and adapted, which meets the condition of an adaptable development process. The third condition is met through the fact that the scrum methodology develops through "small" steps. Through these sprints presentable but not finished products are developed. The fourth condition, guiding the process, is met by the role of the scrum master. The scrum master guarantees the process of development. The fifth comment that is made is that the first key principle of the scrum methodology emphasizes transparency by empirical process control. The sixth condition that is met

by the scrum methodology is the involvement of a variety of stakeholders (perspectives). In scrum development occurs through a multidisciplinary team. Moreover, individual stakeholders are actively engaged, and their interests are taken into account. Condition number seven is related to the changing roles and responsibilities. With the scrum methodology, scrum roles and responsibilities have to be divided among project team members. The last condition of circularity that is directly met by the scrum method is a profitable business scenario. The condition profitable business scenario is met through the leading scrum principle of value-based prioritization.

Thus, the scrum method seems therefore a suitable method for the process strategy for the transition to CUAD and will be applied in this research. In Paragraph 5.2.3, the scrum methodology is explained in more detail.

A few comments have to be made concerning the implementation of the scrum method in CUAD. First of all, not all conditions for circularity are met through the scrum method. Some adaptations should, therefore, be made to the original method. Secondly, one of the significant barriers found in the research is the lack of knowledge. Literature has indicated the lack of scrum application in the construction industry (Coram & Bohner, 2005). Lack of knowledge of the tool should, therefore, be considered when implementing the scrum method in CUAD. Lastly, the scrum methodology itself has some potential problems, such as group or corporate behaviour, which also should be considered when implementing the scrum method (Conforto, Salum, Amaral, da Silva, & de Almeida, 2014).

5.2.3 THE SCRUM METHOD

From the analysis of the case study results and through the literature study on CUAD, the conclusion can be drawn that the scrum method could be a tool to facilitate the transition to CUAD. Scrum is one of the most popular approaches of the agile methodology. The scrum approach was originally developed for the IT sector. Scrum is nowadays implemented in all types of sectors, yet not much in the construction industry (Sonneveld, 2018). Nevertheless, research has been done on implementing the scrum approach in construction projects (Streule, Miserini, Bartlome, Klippel, & Garcia de soto, 2016). The main objective of the scrum methodology is to facilitate an iterative and adaptable process in which a multidisciplinary team works together. The scrum method is then based on six principles related to incremental, transparent and flexible development. These principles are iterative development, empirical process control, self -organizing teams, collaboration, value-based prioritization and time-boxing. Furthermore, the scrum method consists of three elements which are all in line with both the scrum principles and the agile values. The three elements of the scrum method are the scrum events, roles and artefacts. All elements of the scrum method have various tools that can be applied to, for example, organizing or scheduling the events (Satpathy, 2013; de Stoppelaar, 2017).

EVENTS

The first element of the scrum method exists of the scrum events. The events characterise the iterative and interactive process of the scrum. The scrum events guarantee the key factors of the first principle empirical process control. These are transparency, inspection and adaptation. The scrum events are the kick-off, the sprint planning, the sprint and the daily scrum.

Similar to most projects, a scrum project starts with a kick-off. During this kick-off, the product owner creates the product backlog based on the requirements of the stakeholders. Furthermore, in the kick-off, the overall requirements and project activities are determined, and for each item, the state of done is predefined (Satpathy, 2013).

A sprint is a fixed time frame in which the development team plans, creates and reviews and improves the work. The sprint planning is the start of the sprint. A sprint can be divided into the sprint, sprint planning, sprint review and sprint retrospective. Every sprint has a goal that needs to be achieved. This can be translated into a list of items that have to be completed. The duration of the sprint is between one and four weeks. The sprint planning is the meeting in which the work that needs to be done for the next sprint is decided upon and planned. During the sprint planning, the items of

the product backlog are translated into tasks that can be taken on by the development team. During the sprint retrospective, the sprint team evaluate after a sprint, not the work accomplished but how the team and the process functions. The review is an evaluation or feedback moment with the stakeholders after a sprint.

The last scrum event is the daily scrum. The daily scrum is a daily feedback moment in which the development team discusses the work that is done during the past 24 hours within a 15-minute timebox. After that, the development team makes a plan for the coming 24 hours. After the sprint, the sprint and the increment are reviewed by the sprint review and needed adaptations to the product backlog are made. The sprint retrospective is the meeting in which the scrum team critically reviews the work done, the techniques used, and the parties involved.

ROLES

Three main scrum roles can be distinguished: the product owner, the scrum master and the development team (Streule, Miserini, Bartlome, Klippel, & Garcia de soto, 2016). These are also the three roles that are present in the scrum team. The scrum team therefore only consists of the product owner, the scrum master and the development team. The product owner translates the values and interest of the client or customer to the team. The product owner is in charge of the product backlog and is responsible for maximizing the business value.

The scrum master guarantees the continuity of the scrum process. The scrum master has the role of a facilitator instead of the project leader or manager, like in traditional project teams. The scrum master ensures a productive and favourable environment for the team so that project development will be successful.

The scrum development team ideally harbors a variety of disciplines. The development team is responsible for understanding the business requirements described by the product owner and to create deliverables from those requirements. Next to the three leading roles, various small roles exist which do not have to play a role in each scrum project. These roles are included in the term stakeholders. "The stakeholders" is an overarching term that includes the customers, users and sponsors. The product owner is frequently in touch with the stakeholders to ensure their needs are met and to gain input for the project (Satpathy, 2013).

ARTEFACTS

The scrum artefacts are the elements created through the scrum project. The three most essential scrum artefacts are the product backlog, the sprint backlog and the increment (Satpathy, 2013). The artefacts describe the tasks and planning of the project or the process. Artefacts can be seen as a kind of visualized documentation of the work that is done or still needs to be done.

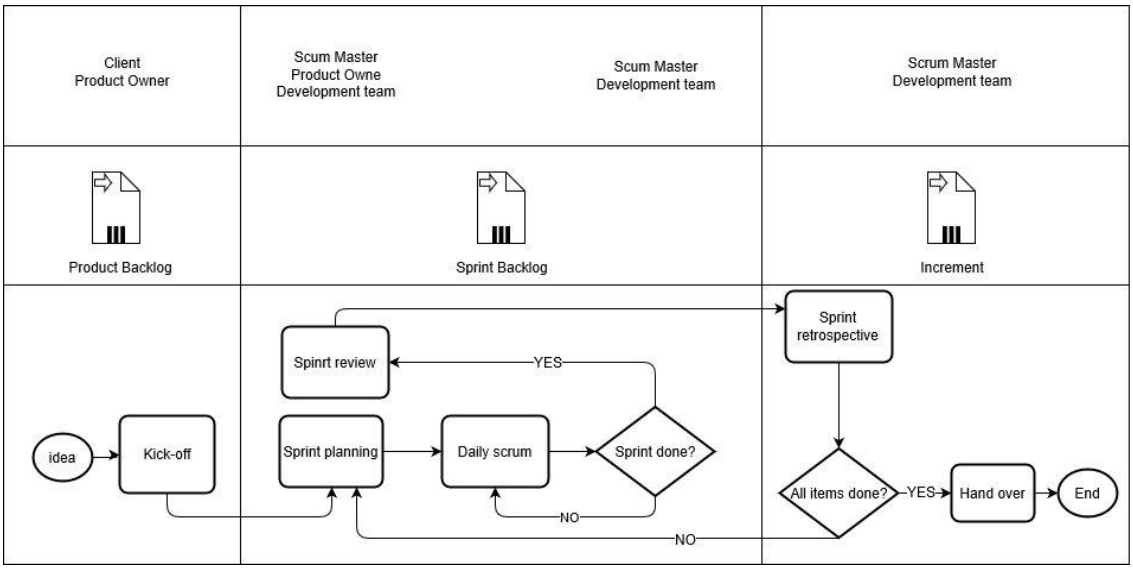
The product backlog is a list of items, which are translated into a set of tasks or actions that have to be done to develop the product or project. Tasks or groups of tasks are addressed to members of the development team (Streule, Miserini, Bartlome, Klippel, & Garcia de soto, 2016).

The sprint backlog is similar to the product backlog but contains only items and tasks related to the sprint. A set of items from the product backlog is selected for one sprint. A sprint backlog contains the items that can be completed during one sprint, according to the development team. The last artefact is the increment. The increment is a list of all items from the product backlog that are completed. A visual representation of the scrum method is shown in Figure 12.

Despite the fact that the scrum approach could fit the transition to CUAD, various challenges and barriers can be found. One of the challenges in the transition to CUAD is the lack of knowledge about new working methods, and this also applies to the scrum way of working. Implementing a new and unknown way of working is rather difficult (Loorbach, 2010). However, through the incremental character of the method, the methodology itself can also be applied in small steps.

Another challenge of applying the scrum method for CUAD process is concerned with the assembling of the team. Scrum suggests an appointed development team (scrum book). However, CUAD is also related to projects in which parties have not been contracted yet. CUAD vision should be established before the tender procedure, which entails that the perspective of the contractor cannot be included. On the other hand, the technical perspective and other expertise can be involved by consultants.

FIGURE 12- THE TYPICAL SCRUM FRAMEWORK



SOURCE: (STREULE, MISERINI, BARTLOME, KLIPPEL, & GARCIA DE SOTO, 2016)

5.2.4 MODIFICATIONS TO THE SCRUM METHOD FOR CUAD

From the 13 main conditions that have to be met for CUAD, eight conditions can directly be found in in the scrum methodology. This means that five of the 13 main conditions for circularity are not met through the scrum method. The original scrum method was developed decades ago for the IT sector and therefore did not include, for example, ReSOLVE strategies, which is of importance for successful CUAD. These five conditions are: include politics, CUAD overview, inclusion of context, the ReSOLVE strategies and technical knowledge. The scrum method should, therefore, be adapted to fit all 13 main conditions. Next to the main conditions, the scrum method is also modified by the concept of CUAD. Furthermore, the research has shown that CUAD is related to the meso-level and the macro-level. The scrum method should, therefore, apply to both levels. The modifications are explained through the elements of the scrum method. Lastly, the scrum method is a new concept for UAD. 'Keep it simple' is, therefore, the key modification, which is applicable for all elements.

EVENTS

Scrum is a relatively new methodology for most construction projects and teams. It is, therefore, advisable to start with a more basic form of scrum. Scrum way of working should be implemented incrementally to decrease the risks of non-acceptance and high learning costs. The number of events should, therefore, fit the project and the scrum team. In construction, project teams are often not physically at the same location or working on more projects at the same time. Daily scrum meetings can, therefore, be complicated. The number of meetings and the intensity of the meetings should be dependent on the project requirements and the scrum team. Next to this, usually all sprints have the same duration. However, the duration of the phases of CUAD can differ a lot. It is, therefore, necessary that durations of sprints can differ. Because, from the case study result, the conclusion can be drawn that having fixed milestones in which the work is evaluated is beneficial for the project (Corbet, Consultant, PERSC, 2019; Kragtwijk, Project Manager, IBB Kondor, 2019). Lastly, during the kick-off, the vision or leading CUAD principles that will be taken into account are finalized or decided upon.

ROLES

The roles of the scrum methodology generally stay the same. Some adaptations can be made to suit CUAD better. First of all, in scrum development projects, the requirements of the stakeholders are guaranteed by the product owner. In CUAD, the product owner should also guarantee CUAD principles. CUAD principles are the substantive aspects of CUAD and could be seen as the requirements for the project.

Furthermore, through the lack of (technical) knowledge on CUAD, it can be beneficial to start with a large project team. This project team could become smaller per sprint. CUAD development teams should, therefore, not entirely be fixed. Moreover, the development team should consist of all relevant expertise for the whole life cycle of the project. An overview of the involved actors should, therefore, be made. By including CUAD principles and vision in the procurement, the contractor can show his perspective through the tender application.

Lastly, looking at the different levels, the area or a single building, scrum roles should be divided depending on the level. On a macro-level, the initiating party can be the municipality or the developer. The scrum master and the product owner are derived from the initiating parties, the development team consists of different parties within the CUAD process, for example, the architect and a consultant engineer. Examining a single building or the meso-level of implementation, the developer is often the initiator and the development team can now also include the contractor. The contractor should be included in the development team after the tender. However, the tender application should already contain a CUAD vision for the building project.

ARTEFACTS

The product backlog is the most important artefact. The product backlog consists of all requirements for the whole project. For CUAD, this entails that the product backlog should also include CUAD requirements or strategies. The product backlog lays down the foundations for ReSOLVE strategies that should be applied. Furthermore, the product backlog should require to anticipate on politics and all other essential context variables. The product backlog is, therefore, next to the requirements of the product, the scope of the project and describes the substantive or technical aspects of CUAD

5.3 THE CUAD FRAMEWORK

With some adaptations, the scrum methodology could fit CUAD. Together, the following elements and the conditions for circularity form the framework for CUAD.

5.3.1 EVENTS

In the CUAD, the duration of the scrum and the daily scram have been adapted or removed to fit CAUD (see Paragraph 5.2.4). Moreover, in the original scrum method, the sprint planning is done only by the development team. However, through the lack of knowledge of scrums in the construction industry, it is preferable that both the scrum master and the development team develop the scrum planning. In any case, the scrum master should have knowledge about the scrum way of working.

5.3.2 ROLES

CUAD needs one guiding party and active involvement of the client. Furthermore, CUAD needs a multidisciplinary approach and can, therefore, enhance a scrum way of working. The traditional roles of CUAD, like the client, developer and contractor, still exist, however, those parties have been categorized into scrum roles in the CUAD framework.

STAKEHOLDERS

The stakeholder role is similar to the role of the traditional client and other actors in CUAD. However, the stakeholder is also seen as the user, which in the CUAD context means the resident or the renter. In the case of the scrum method, the client is the actor who makes use of the project/area/building. The relationship with clients is similar to those in the standard scrum method.

PRODUCT OWNER

The product owner is responsible for the requirements of the client and belongs to the scrum team. In CUAD, the requirements are related to values of stakeholders but also to the general CUAD vision

for the area or the project. In CUAD this entails that the product owner belongs to the initiating party. For CUAD this can be the developer or the municipality. It is important that the product owner is often in contact with the development team to share information. This entails that in some cases the municipality should be actively involved to ensure the requirements if, for example, the product owner is an employee of the municipality.

SCRUM MASTER

The scrum master is part of the development team and facilitates the scrum way of working. In CUAD, it is of importance that the scrum master also facilitates CUAD principles. The facilitating and guiding role of the scrum master indicates that the scrum master is an initiator. The scrum master should be chosen from the party that puts together the project team. In most cases, this is done by the developer. Furthermore, scrum is still a relatively unknown concept in the development industry. It is of importance that at least the person that is allocated as the scrum master knows the scrum methodology.

THE DEVELOPMENT TEAM

The development team consists of all parties or expertise working on the project. The development team is constructed by the initiator and should consist of all parties relevant to the whole project life cycle. However, the size and people belonging to the development team can change over time. Case study results have shown that in some building projects, just a few actors need to be involved in the initiation phase. On the other hand, in other building projects, it is crucial to gather as much knowledge as possible in the beginning. The size of the development team should increase in, for example, the design phase, while the construction phase needs a smaller development team. It is the product owner's task to decide, for each phase, which is part of the development team. Nevertheless, the core team should stay constant, which ensures continuous knowledge sharing. The last focus point for the development team is that the values of the team should continuously be considered. Guiding the development team is related to facilitating the process and does not imply top-down imposing.

5.3.3 ARTEFACTS

Three main artefacts exist in the scrum method, of which the most important is the product backlog. Most artefacts of the traditional scrum method do not need many modifications to fit CUAD. However, some adaptations should be made to the product backlog. First of all, the vision for CUAD should be guaranteed by including ReSOLVE strategies as conditions for the product backlog. At the beginning of the project, a decision should be made which strategy or strategies of the ReSOLVE framework for CUAD will be followed for the development of the area. Strategies should be chosen that fit the area currently best and have the potential to be useful on a larger scale

Secondly, to guarantee that the development of the area will be realised, the project should anticipate on politics and other external factors. The product backlog should, therefore, consider politics and context variables. The third comment that can be made about the product backlog is the fact that the product backlog is created traditionally by the product owner and the scrum master. Because of the lack of knowledge about the scrum approach and about CUAD, it is advisable to increase the knowledge by including expertise about scrum, circular economy or technical aspects of the built environment if necessary.

5.4 CONCLUSION

Based on the analysis of the literature study and the case studies, 13 conditions for circularity have been developed. These conditions for circularity inform the process framework that facilitates the transition to CUAD. Adaptability, a variety of users and a shared vision on CUAD are the most important conditions for circularity. Moreover, the process strategy needs to be an iterative, incremental and multidisciplinary approach. The scrum method is therefore chosen as a potentially applicable method to facilitate the CUAD process.

However, to fit all conditions for circularity, adaptations have been made to the scrum method to fit the proposed process strategy for CUAD. For example, the technical aspects of CUAD like the ReSOLVE strategies are taken into account to include circular principles in the product backlog. These

strategies in the development of the area will be the ultimate responsibility of the product owner. Furthermore, the product backlog should guarantee the inclusion of politics and context variables. Lastly, for the kick-off, it is preferable to have as much (technical, environmental and policy) knowledge as possible to shape the vision for implementing ReSOLVE strategies. Furthermore, during the kick-off, an overview of all parties and activities involved during the whole life cycle of the project should be made.

The modified scrum method for CUAD is called the CUAD framework and meets both the technical and managerial aspects of CUAD. The CUAD framework could facilitate the transition to CUAD by incorporating the conditions for circularity in the scrum way of working.

6. THE PILOT STUDY

SOURCE: (OWN WORK)

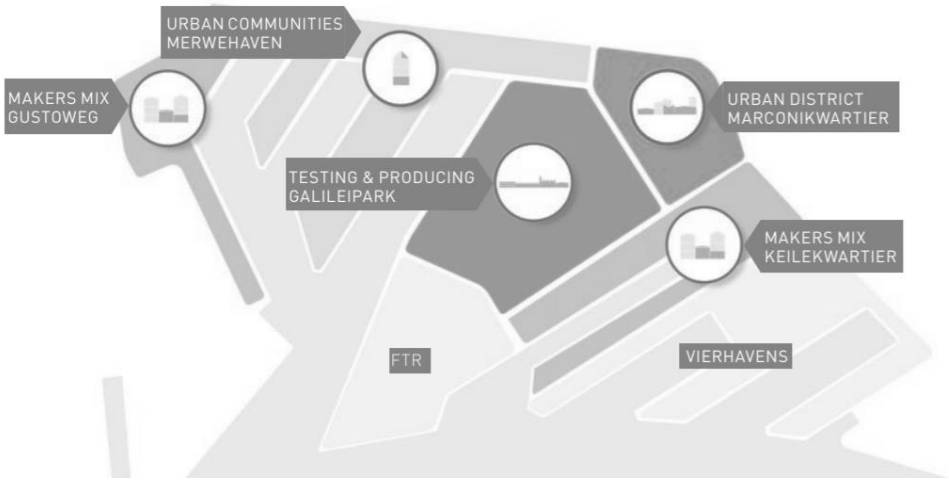
This Chapter describes the pilot study conducted to test the CUAD framework. The pilot study is conducted as part of the development of the master plan for the Galilei Park in M4H. First, an introduction is given about M4H in Paragraph 6.1. The second Paragraph two (6.2) explains the pilot study design. After that, the result of the CUAD pilot is given in Paragraph 6.3. The last Paragraph (6.4) concludes with an analysis of the outcome of the pilot through the feasibility criteria.

6.1 INTRODUCTION TO M4H

The objective for the development of is to consolidate city and port in the area. The municipality of Rotterdam and the PoR Authority aim to develop the area into a mixed area. This objective is, therefore translated into one of the five objectives of the Rotterdam Makers District. This objective states that: "The district should have an open innovation environment with a varied mix of companies, education and knowledge institutes" (Paragraph 1.1 of Chapter one).

The area of M4H consists of five sub-areas which are Gustoweg, Merwehaven, the Galilei Park, Marconikwartier and the Keilekwartier. The difference between the development process of these areas is related to the ratio of the city (housing) and port (industry/business) (Rotterdam Makers District, DELVA, Site Urban Development, Skonk, & Goudappel Coffeng, 2019). The subject of the pilot study is the development of the master plan of the Galilei Park. The Galilei Park will become the place for the manufacturing industry. No residential building will be developed in the Galilei Park. This area also offers space for activities that support the manufacturing industry, such as offices and the catering industry. Figure 13 displays M4H and the five sub-areas.

FIGURE 13- M4H



SOURCE: (ROTTERDAM MAKERS DISTRICT, DELVA, SITE URBAN DEVELOPMENT, SKONK, & GOUDAPPEL COFFENG, 2019)

URBAN AREA DEVELOPMENT

The Ruimtelijk Raamwerk is agreed upon by the council of the municipality of Rotterdam in June 2019. The Ruimtelijk Raamwerk is an urban plan which illustrates the urban vision for M4H. The Ruimtelijk Raamwerk has developed an urban and sustainable vision for 2035 and 2050 in which the aim is to become the area for an innovating living and working environment (Rotterdam Makers District, DELVA, Site Urban Development, Skonk, & Goudappel Coffeng, 2019).

STAKEHOLDERS

Various entrepreneurs are already located in the area. All with different activities which are related to manufacturing, design, circularity, IT or building and infrastructure. The municipality of Rotterdam and the PoR Authority are the leading parties concerned with redevelopment of M4H. The municipality of Rotterdam and the PoR Authority has developed the Ruimtelijk Raamwerk together with architect DELVA, Site Urban Development, Skonk, Goudappel Coffeng, Plusoffice Architects, Kettinghuls and A2 Studio.

THE OBJECTIVE ON CUAD

The fifth objective of the Rotterdam Makers District is to develop M4H as a pilot for CE in the built environment of Rotterdam. Previous research by Team1010 has resulted in opportunities for transition to CE in the built environment of M4H (Team 1010, 2019). These opportunities have been summarised and translated into eight leading circular principles for the redevelopment of M4H. These eight circular principles are described in the Ruimtelijk Raamwerk. Implementation of CUAD should follow these eight circular principles, which are (Rotterdam Makers District, DELVA, Site Urban Development, Skonk, & Goudappel Coffeng, 2019):

1. M4H offers space for all type of business that is focussed on (small) manufacturing
2. M4H prefers shared facilities above individual ownership
3. M4H provides a place for experimenting and learning
4. M4H uses and exchanges sustainable energy
5. M4H values residual flows
6. M4H helps business, inhabitants and visitors to choose sustainable transportation
7. M4H designs the outside space in such a manner that it functions as a resilient and adaptive climate system.
8. M4H will be redeveloped according to the industrial character and capacities of the area.

6.2 CUAD PILOT DESIGN

The pilot design is based on the pilot study factors (Paragraph 3.3.1) and the CUAD framework developed through this research. The pilot study factors are shortly described in Paragraph 6.2.1. The CUAD framework consists of the conditions for circularity and the elements of the scrum method. Paragraph 6.2.2 elaborates on the conditions for circularity applied in the pilot study and Paragraph (6.2.3) describes how the elements of the CUAD framework are applied in the pilot study.

6.2.1 PILOT STUDY FACTORS

The sample size, which includes subject, project phase and the actors involved, is based on the objective and the context of the research. The goal of the pilot study is to implement the circular principles of M4H that are in line with the concept of CUAD -developed through this research- in the master plan of the Galilei Park. Moreover, the research has shown that incorporating circular strategies in UAD can be useful if the initiator does it at the start of the project. Nonetheless, the initiation phase of the development for CUAD should start with the questions "What do you have in the area and what can you do with it" (Boswinkel, Developer, Local, 2019). Six people have participated in the pilot study. The participants of the pilot study can be found in Table 13.

Next to the objective and the sample size, the pilot study factors consist of the feasibility criteria. Seven feasibility criteria are developed for this pilot study which can be found in Paragraph 3.3.3 of Chapter three.

6.2.2 CONDITIONS FOR CIRCULARITY

The pilot study design aims to incorporate all the conditions for circularity through the CUAD framework. The focus of the CUAD framework for the pilot study is an adaptable process through two sprints with an architect, environmental consultant and an engineer. The vision for CUAD is met through (one of) the eight circular principles that fit the ReSOLVE strategies of the CUAD framework. Furthermore, the process of guiding the vision of CUAD is guaranteed through the designated scrum master and product owner.

6.2.3 ELEMENTS OF THE CIRCULAR SCRUM PILOT

The three elements of the scrum method -events, roles and artefacts- are modified to fit CUAD. One of the essential conditions for circularity is to take the context into account. Including context, entails that roles, responsibilities and events of the CUAD framework are likewise adapted to fit the

circumstance and context variables of the pilot design factors. Table 12 shows which elements will be included in the pilot.

TABLE 12- ELEMENTS OF THE CUAD PILOT

SCRUM TEAM				SCRUM EVENTS					SCRUM ARTEFACT		
Stakeholder	Product Owner	Scrum Master	Development team	Sprint	Sprint planning	Daily scrum	Sprint review	Sprint retrospective	Product Backlog	Sprint Backlog	Increment
✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓

SOURCE: (OWN WORK)

EVENTS

Almost all scrum events are applicable to the pilot study. According to the CUAD framework, the daily scrum will not be applied in the pilot. Though, the daily updates of the work completed will be done by an online platform. During the kick-off meeting, the CUAD vision is determined with the help of the expertise of an environmental expert of the PoR Authority.

Next to the daily scrum, the sprint retrospective has some variations to the definition and application as described by the literature. The development team evaluates each sprint through the sprint retrospective, which consists of a small questionnaire. This questionnaire is analysed by the scrum master. The results of the feedback are incorporated at the start of the new sprint. The sprint retrospective and the sprint planning, therefore, are connected and combined at the start of the following sprint.

ROLES

From the CUAD framework, the conclusion can be drawn that the scrum roles that have to be taken into account are the stakeholders, the product owner, the scrum master and the development team. One of the objectives of the pilot study, however, is to keep the sample size small. Most roles of the scrum team are therefore filled by the PoR Authority.

The Galilei Park will be developed by the PoR Authority but also belongs to the municipality of Rotterdam. Therefore, during the pilot, an employee of the municipality of Rotterdam plays the role of the client and employees of PoR Authority play the role of the developing party. Furthermore, due to the small size of the project, engineering and environmental knowledge fit also in the expertise of the PoR Authority. The PoR Authority is, therefore, also a part of the development team. Lastly, through schedule difficulties, the architects of DELVA could not participate in the pilot study. However, the project leader for the Galilei Park is consulted by DELVA architects and guarantees the perspective of the architect for the pilot study. The participants of the pilot study and their roles are described in Table 13.

TABLE 13- PARTICIPANTS OF THE CUAD PILOT

ACTOR	TRADITIONAL ROLE	SCRUM ROLE	NAME
THE ROTTERDAM MAKERS DISTRICT	Client	Stakeholder	
POR AUTHORITY	Developer	Product owner Scrum master	
	Engineer	Development team	
	Consultant	Development team	
"DELVA"	Architect	Development team	

SOURCE: (OWN WORK)

ARTEFACTS

The final aspects that have to be taken into account for the CUAD pilot are the artefacts. All three artefacts: product backlog, sprint backlog and increment will be applied in the pilot. A Kanban board will visualise the artefacts. The Kanban board is a tool to visualise the development process. The

Kanban board displays the different items of the product backlog: which items belong to the sprint, which can be classified as work in progress and which are completed (Heikkilä, Paasivaara, & Lassenius, 2016).

It is essential for the product backlog of the CUAD framework that the vision for CUAD is incorporated. The CUAD vision is incorporated through the eight circular principles for M4H. From the results of this research, the assumption can be made that enough knowledge has to be gained at the start of the project for effective CUAD implementation. The product backlog is therefore created with the expertise of environmental and engineering consultants of the PoR Authority.

6.3 RESULTS OF THE CUAD PILOT

The pilot study consists of developing the master plan for the Galilei Park, and this is part of the initiation phase of developing the area. The first step before the actual pilot can be conducted consists of gathering the project team. This step does not belong to one of the events of the CUAD framework but is essential and takes time. During this step, the scrum methodology is explained to the participants of the pilot, assuming that most team members are not familiar with the scrum methodology. The following subparagraphs of Paragraph 6.3 describe the outcome of the different events of the CUAD pilot. Elaborated lists of all activities and outcomes of the scrum sessions can be found in Appendix E3.3.

6.3.1 KICK-OFF

During the kick-off, the objective of the pilot study is defined. The kick-off consists of an introduction of the project, scrum and the team members. After the introduction, the goal of the CUAD pilot is established. After establishing the general goal of the pilot, the goal is translated into concrete tasks which are prioritised for the product backlog.

The objective of the pilot is to incorporate one of the eight principles in the master plan of the Galilei Park. During the kick-off principle number five “M4H values residual flows” has been selected by the development team as the most applicable and fitting principle for incorporating CUAD strategies in the master plan. Selection of the principles has been accomplished by the expertise of the participants and a ranking game.

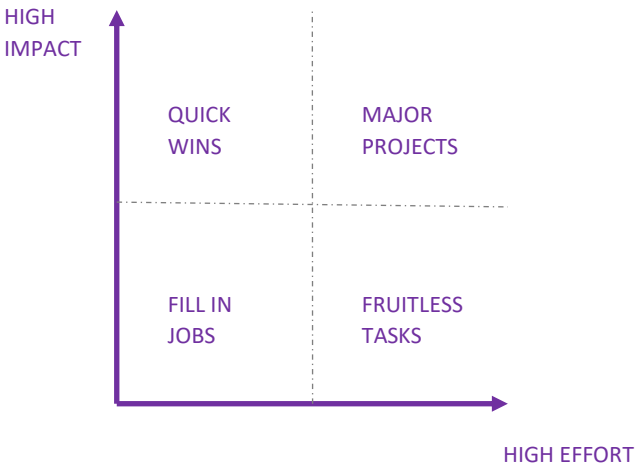
Principle five is the leading principle to incorporate CUAD. The principle "M4H values residual flows" is translated into concrete actions and tasks by a brainstorm session. The team members are asked to define what "M4H values residual flows" meant or "What it consists of"? The results of the brainstorm session are prioritised, first, by categorising the items by their impact versus their effort, secondly, by ranking the strategies according to the 10r framework.

Prioritisation through impact versus effort is focussed on the duration of the task. This due to the fact that the duration of the pilot study was only three weeks. It must, therefore, be possible to complete the goal of the pilot in three weeks.

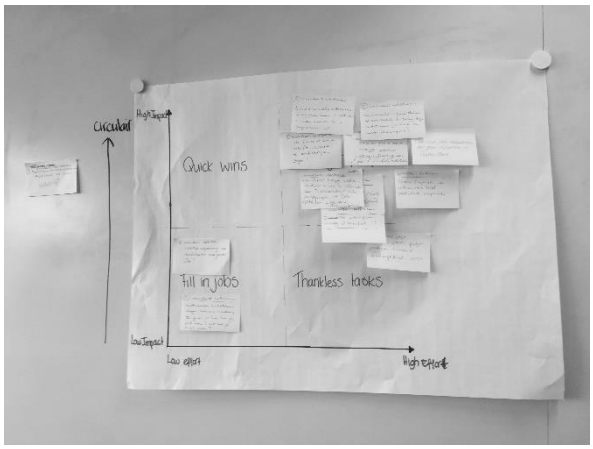
Three tasks have come forward as quick wins with a rather high circular impact. Quick wins tasks can be indicated as tasks which have a high impact and do not take much effort. These three tasks are all applications of sustainable materials, temporary storage for used materials and communication channels concerned with valuing waste flows.

Based on these tasks, the product backlog is developed and prioritised. Furthermore, a concept is made for the sprint backlog. The task "application of sustainable materials omitted because this task has the lowest priority of the three through its rather long duration to complete the task. The product backlog, at the end of the kick-off meeting, consists of the tasks “Temporary storage for used materials” and “Communication channels". In which temporary storage has been identified as the first task for the sprint backlog. Temporary storage for used materials has been translated into concrete actions by asking the question "What does a contemporary storage place consist of"? The kick-off meeting concludes with the concept for the sprint backlog. In Appendix E3.3, all tasks and actions created through the kick-off can be found. Figure 14 gives an impression of the kick-off meeting.

FIGURE 14- VISUAL REPRESENTATION OF PRIORITISING TASKS DURING THE PILOT



b) GRAPHIC BOARD



a) PILOT BOARD

6.3.2 SPRINT I

The first sprint, like all other sprints, starts with the sprint planning. Besides the sprint planning, the sprint consists of a sprint review and retrospective. These events are in this pilot summarised in a questionnaire and are dealt with during the sprint planning meeting.

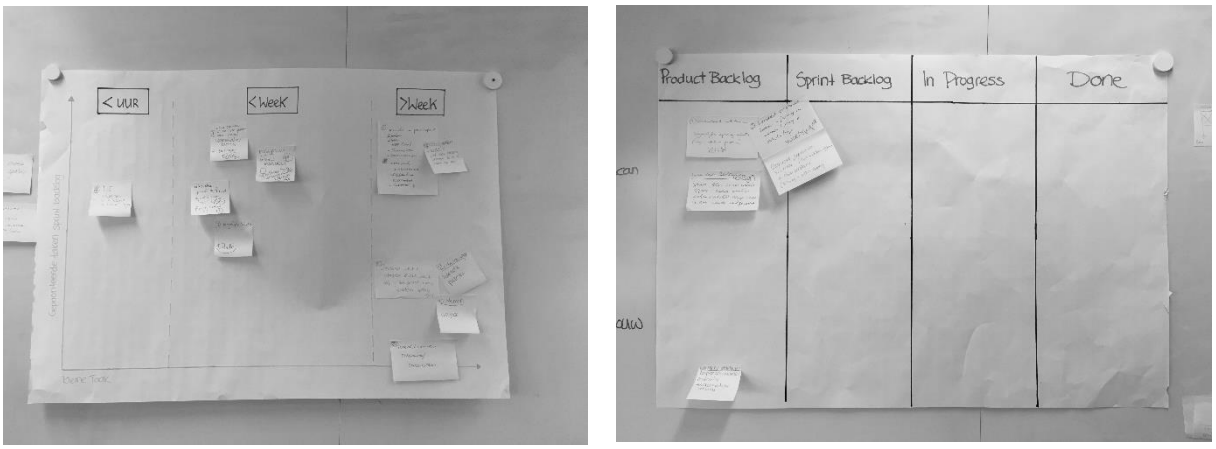
During the sprint planning, the tasks that need to be done to complete the goal of the sprint backlog are determined. Therefore, the objective of the sprint planning is to determine and plan the tasks belonging to the first goal, temporary storage for used materials. Figure 15-a illustrates the board used to plan tasks during the sprint.

The sprint planning is held with the scrum master, product owner and the scrum team. The sprint planning starts with a recap of the kick-off. During the kick-off, several tasks for the sprint goal were already established. Through the recap of the kick-off, the tasks created for the sprint backlog are shortly evaluated. This results in the conclusion that the sprint backlog list is quite long.

During the first sprint planning, the main tasks or actions have been developed and prioritised for the temporary storage place. Three of the five tasks had to be divided into smaller tasks. After developing the tasks, the tasks are prioritised. Time is an important constraint for the pilot and is, therefore, leading in the prioritisation of the actions. The five actions are: analyse interested and involved actors, determine the programme of requirements (Dutch; Programma van Eisen (PVE)), select locations for the storage place, map out material flows of M4H and examine what kind of management system is needed.

Next, a planning was developed for the tasks of the sprint. Items were categorised through the duration of the task. Can the task be completed in an hour (during the meeting), can the task be completed in a week or does it take longer than a week? This analysis resulted in only one task that could be completed in a week and two whole tasks that could be done during the first sprint, so within a week. Some tasks consist of subtasks. This resulted in some actions that could be done in a week and other actions from the same tasks that took longer than a week. During this first sprint planning, the PVE has been developed. And the tasks that could be done during one week have been divided among the development team. Overview of the tasks and decisions developed during the first sprint planning can be found in Appendix E3.3. Figure 15 is an illustration of the first sprint session.

FIGURE 15- REPRESENTATION OF THE PILOT SPRINT PLANNING



a) DURATION CATEGORISATION BOARD b) PRODUCT BACKLOG

6.3.3 SPRINT II

The objective of the second sprint is to determine and plan the remaining tasks of the updated product backlog. The remaining tasks belong to the contemporary storage place. The product backlog developed by the kick-off consisted of goals as temporary storage and communication channels. However, the first sprint has indicated that the actions of developing a plan for temporary storage take longer than one week.

The introduction of the second sprint planning started with a recap of the actions done and the decisions made during the first sprint. All team members of the development team had completed their tasks. An overview was made of the current interested parties, a document of the legal framework for residual materials was presented and four possible locations had been pointed out. Furthermore, the second sprint planning started with considering the lessons learned from the first sprint.

The lessons learned are based on the sprint retrospective. The development team has indicated what went well during the first sprint, what could be improved and what could be added or left out of the planning meeting. From the sprint retrospective, three lessons learned are captured: being concrete, the structure of the meeting and role specification. All members of the development team indicated that they experienced the meeting as concrete and goal-oriented. The second sprint planning, therefore, uses the same planning tools.

A comment was made on how to improve the scope of tasks. The development team pointed out that they were unsure if all aspects were handled. The second lesson learned is focused on the structure. Before starting the actual planning, the team was asked to consider again the actions for the temporary storage place based on an action for materials hub of another case. This resulted in an adapted sprint product backlog in which the actions scale, schedule/planning and culture and behaviour were added.

The last lesson learned is related to the development team itself and their roles. The development team was asked to comment on their role for this pilot and on the actions related to the development process. This was done by recapping the scrum roles and the tasks and responsibilities belonging to the roles. Comments on CE or sustainability, in general, was not part of this session.

Through the recap and lessons learned of the first sprint, the conclusion was drawn that the actions for implementing a temporary storage place in the master plan of the Galilei Park were already completed. The remaining tasks of the temporary storage place are related to the realisation of the project. Therefore, the duration of most of the remaining tasks is longer than a week. However, general decisions or assumptions can be made about the scale, duration of planning and what kind of aspects have to be considered for the business case of the temporary storage place. The second sprint planning was wrapped up with the decision to document the findings from the pilot study into a pre-project plan. Furthermore, the development team will answer again the questions for the retrospective and the idea of implementing temporary storage in the master plan of the Galilei Park which will be presented to the municipality of Rotterdam in the last week of the pilot.

6.4 CONCLUSION ON THE CUAD PILOT

The success of the pilot is measured by the feasibility criteria. These criteria are based on the objective of the pilot study, which is analysing if the process of CUAD can be facilitated through CUAD framework. The feasibility criteria are categorised in criteria which measure the success of CUAD implementation and success of CUAD framework. Appendix E3.2 describes in more detail the feasibility criteria, their results, and how the feasibility criteria are measured.

CUAD FEASIBILITY CRITERIA

The CUAD criteria are concerned with the definition of CUAD, the outcome, the process and the actors. The definition of CUAD is focussed on considering the whole project life cycle at the beginning of the project. The selection of the location of the storage plan is based on the number of years the storage place will be used to store materials mined from (re)development of M4H. The construction of the storage place itself, however, has not been considered. It is therefore difficult to draw conclusions about the consideration of the life cycle of the storage.

On the other hand, hard conclusions about meeting the criteria can be drawn by examining the outcome of the pilot study. The storage place for used materials mined from the development of M4H fits in re-use strategy of the 10r model, which ranges in the top five strategies. Furthermore, the temporary storage place will first of all be taken into account in the master plan, and secondly, a pre-project plan will be developed for possible realisation. Therefore, the conclusion can be drawn that the intention for a follow-up exists.

The third feasibility criterion concerns the process. The criterion states that the process is successful if the pilot study has at least two feedback moments. Three feedback moments are incorporated in the pilot. The first two are concerned with the retrospective, and the third is the sprint review in which the outcome of the pilot is reviewed with the client.

The last feasibility criteria related to CUAD is concerned with the actors involved. Is a variety of stakeholders involved, like engineers and designers? And is the project designed for the (end) user? The engineer is included in the project. However, the designer not directly. But the perspective of the designer is considered through the project leader of the Galilei Park. Moreover, the users are not (yet) incorporated in the design of the storage place. This due to the fact that the design has not yet been made. However, an analysis is made of the possible actors and parties interested in the storage place.

SCRUM FEASIBILITY CRITERIA

The scrum feasibility criteria consist of increased knowledge of scrum, positive feedback of scum way of working and the intention to have more try-outs with the CUAD framework. These three feasibility criteria are measured through review meetings and a small questionnaire. The retrospective questions and the feedback questions can be found in Appendix E2.

From the feedback questions, the conclusion can be drawn that the CUAD framework criteria have been met. The feasibility criteria are related to the knowledge of scrum, positive feedback of the

framework, and if the intention exists for a follow up. The participants of the pilot have answered the questions concerned with knowledge about scrum correctly. All participants were familiar with their roles and the elements of scrum. Furthermore, the application of scrum in design or development projects like the development of the master plan is evaluated as more than satisfactory. Moreover, the overall impression of scrum has been evaluated as more than satisfactory too. The last feasibility criterion is concerned with follow-up. As stated before, the possibility exists of developing the project plan for the temporary storage place. Thus, from the pilot study, the conclusion can be drawn that all feasibility criteria for implementing CUAD are generally met.

7. REFINEMENT OF THE FRAMEWORK

SOURCE: (OWN WORK)

Through the literature study and the case studies, the conditions for circularity are developed. These conditions are the foundation for the CUAD framework, which is tested through the pilot study described in Chapter six. Based on the results of the pilot study, the CUAD framework is refined. This Chapter describes the modification to the CUAD framework and the final CUAD framework by examining the designed pilot study and the actual pilot study results.

This Chapter consists of four Paragraphs in which the first Paragraph describes the conditions and the elements of the original pilot study design versus the conditions and the elements of the pilot study results. The second Paragraph describes the adaptations made to the CUAD framework. The adaptations made are the input for the final CUAD framework, which is described in Paragraph three. The fourth and last Paragraph contains the conclusion.

7.1 ANALYSIS OF THE DESIGNED PILOT STUDY VERSUS THE RESULTS OF THE PILOT STUDY

The CUAD framework includes both the conditions for circularity and the three elements of the scrum method. Hence the CUAD framework combines the scum way of working to fit the conditions for the transition to circular urban area development. The analysis of the conditions and the elements focus on the variations between the pilot study design and the pilot study results. From the analysis of the designed framework and the applied framework, the conclusion can be drawn that the applied framework is different for only three of the 13 designed conditions and two of the three elements. The pilot study meets the main conditions for circularity by adaptable development through sprints, development of CUAD vision and development through a multidisciplinary team.

7.1.1 PILOT STUDY DESIGNED CONDITIONS VS PILOT STUDY RESULT CONDITIONS

Examining the conditions for circularity, the conclusion can be drawn that only three conditions have not (entirely) been met through the pilot study. These conditions are indicated in Table 14 by the purple letters. The three conditions that not (entirely) have been met are: include politics, transparency and inclusion of context. Table 14 describes how the conditions are incorporated in the pilot study.

The conditions, including politics, has only been partly met through the Ruimtelijk Raamwerk. The starting point of the master plan is the Ruimtelijk Raamwerk, which has been agreed upon by the council of the municipality of Rotterdam. However, this cannot indeed be seen as including politics by go/no-go moments or risk communications. The research has shown the importance of including politics in decision making. Including politics for CUAD often exists of including decisions or agreements of the council (Kleemans, , project leader, municipality of The Hague 2019). Without the inclusion of politics through, for example, go/ no-go moments, building projects can be rejected or stopped (Olander & Landin, 2005). On the other hand, go/no-go moments or risk communication are activities not related to developing the master plan but are concerned with phases in a later stadium of the project like feasibility study for the realisation.

Examining the condition transparency, the conclusion can be drawn that transparency, as defined by this research, has not been met through the pilot. This is because the findings from the sprints and the findings from the overall pilot study have not (yet) been shared with actors outside of the project team. Despite that, transparency has come forward as an essential element for sharing and increasing knowledge about CUAD. The lack of transparency is a result of both lack of time as well as (organisational) procedures. For instance, DELVA could not participate in the pilot study due to the short timespan in scheduling the pilot. Furthermore, it is difficult for a municipality, for example, to include or communicate findings with a contractor before the tender.

The last condition, which is only partly met by the pilot study, is the inclusion of context. Inclusion of context can consist of various aspects like the economic or legal setting of an area. An aspect that comes forward as one of the most important factors to consider in project development throughout the pilot study is time. However, time or time constraints are seldom mentioned in this research. The long duration of building projects has been mentioned as a hurdle for implementing circularity in both the case study of Binckhorst and of Park 20I20. Time as a constraint or shortage of

time, on the other hand, has not come forward by literature or the case studies. The pilot study nevertheless has shown the importance of the time constraint, and several examples can be distinguished. The first example is concerned with the start of the pilot. Gathering the project team members and scheduling meetings is rather tricky through the fact that most people have several other tasks and projects.

Secondly, the time aspect influences the scope of the project. Because within the scrum method, the schedule is strict and therefore decides on the number and complexity of the tasks the development team can take on. Furthermore, the concept time decides which project can be considered for CUAD. It is challenging to incorporate a CUAD vision or strategy into projects which already have started. The final CUAD framework, similar to the original scrum methodology, should incorporate time management. An elaborated description of how conditions are implemented in the pilot can be found in Table 15.

TABLE 14- THE CONDITIONS FOR CIRCULARITY IMPLEMENTED IN THE PILOT

	CUAD PILOT DESIGN CONDITIONS	RESULT IMPLEMENTATION OF CONDITIONS IN CUAD PILOT*	
ADAPTABLE PROCESS	Multiple sprints	+	Two sprints
INCREMENTAL TRANSITION	One-week iterations	+	Focus on one single principle
NEED FOR GUIDING	CUAD focus (scrum master & product owner)	+	CUAD focus (scrum master)
INCLUDE POLITICS	"Based on (agreed upon) Ruimtelijk Raamwerk"	+/-	Based on Ruimtelijk Raamwerk but does not include risk communication
TRANSPARENCY	Decisions/session shared with parties outside of the project team	-	The outcome of the sessions has not (yet) been shared with parties outside of the project team
VARIETY OF INVOLVED STAKEHOLDERS	Including actors outside of the scope of developing the Galilei Park	+/-	Include a project engineer of another project
CHANGING ROLES AND RESPONSIBILITY.	Designate the scrum roles and responsibilities	+	Designate the scrum roles and responsibilities
CUAD (ACTORS/ ACTIVITIES) OVERVIEW	Analysing what type of knowledge is necessary for the objectives and tasks	+	Analysing all interest actors for the temporary storage
VISION DEVELOPMENT	Kick-off selects the CUAD vision based on ReSOLVE strategies	+	Kick-off indicates vision through circular principles of M4H
PROFITABLE BUSINESS SCENARIOS	Prioritisation of the objectives and tasks	+	Prioritisation based on Impact and Effort. The effort is defined as time and resources
TECHNICAL KNOWLEDGE	Include experts (consultants and engineers) during the kick-off to increase knowledge	+	Include experts (consultant and engineer) during the kick-off to increase knowledge
RESOLVE STRATEGIES	Selecting only circular principles that are in line with CUAD ReSOLVE strategies	+	Select the of circular principles that are concerned with construction flows
INCLUSION OF CONTEXT	Legal and economic boundaries should be analysed	+/-	Variables that have been considered are the duration of the pilot, schedule of the project team, and legal boundaries

SOURCE: (OWN WORK)

7.1.2 PILOT STUDY DESIGNED ELEMENTS VS PILOT STUDY RESULT ELEMENTS

The CUAD framework consists of the elements: events, roles and artefacts. All three elements have been adapted to fit the context of the pilot study, as described in Chapter six. However, during the pilot study, more modifications have been made to the elements of the framework.

EVENTS

Analysing the CUAD framework events applied in the pilot study, three comments can be made. The duration of the pilot study sprint is one week. Which has been classified as rather short by the project team. The sprint duration prescribes that tasks that have to be completed in a week which narrows the scope of the tasks that can be completed. However, it does give structure and progress in the decision-making process.

The second comment related to the sprint events is concerned with the sprint planning. In the original framework, the sprint planning is only concerned with prioritising and planning of the task. The pilot study has shown the benefits of already completing "tasks" by making decisions during sprint planning. Because during the sprint planning, the whole development team is together. The different perspectives on the task and decisions that need to be made are beneficial for decision making.

The last comment that can be made concerning the events of the CUAD framework is related to the scrum review. The pilot design describes that after every sprint, the client is consulted by the sprint review. Unfortunately, it was not possible during the pilot study to consult the client about the completed task before the second sprint. Nevertheless, the completed tasks within the first sprint were just fragmented pieces of the project. Communicating fragmented solutions or parts of decisions does not increase understanding or increase communication with the client.

ROLES

The four leading scrum roles have been applied in the pilot study as defined by the CUAD framework. However, the division of the responsibilities from the scrum master and product owner have changed during the pilot study. During the sessions the argument was made that the scrum master and the product owner have many tasks in common. The content of the tasks does not occupy both the scrum master as the product owner. In general, the product owner guarantees the interest of the stakeholders as the CUAD vision, and the scrum master guarantees the process. However, due to the workload of developing the plan for the temporary storage and due to the duration of the pilot, the decision was made to combine the tasks of the product owner and the scrum master. This resulted in an "extra" member of the development team. Due to the small size of the pilot study, the group of stakeholders and their requirements, it is manageable for the scrum master to guide the process and take on the responsibilities of the product owner.

ARTEFACTS

No significant modifications have been made to the artefacts. All three artefacts have been used: the product backlog, the sprint backlog and the increment. The artefacts have been visualised with the help of the Kanban board. The pilot study has applied a physical Kanban board with post-its and a virtual Kanban board which was created with a spreadsheet of Google Drive. The scrum master was the only one who used the physical Kanban board. However, the virtual Kanban board has been used by the development team.

7.2 ADAPTATIONS TO THE FRAMEWORK

The adaptations to CUAD framework are described by the elements of the scrum method: roles, events and artefacts. The adaptations consist of both adaptations to the conditions and the elements of the framework.

EVENTS

Several modifications should be made to improve the events of the CUAD framework. These modifications are related to the sprint planning and the sprint review. Furthermore, the adjustments to the events are related to the inclusion of the modified condition of context, which should also emphasise the aspect of time (constraint).

For the sprint planning, it is first of all essential to include the aspect 'time'. The first sprint planning should consist of examining the element of time by indicating the time and resources the development team has for the whole project. The second comment that is relevant for the sprint planning is that decision making should be incorporated in the sprint planning. In the scrum, method tasks are only appointed to the team members. However, most tasks contain decisions that have to be made. Decisions should be made, for instance, which elements are taken into account for the program of the requirement of a project. This could be done during the sprint with the knowledge of all experts. Therefore, by prioritising tasks and decisions, important decisions should be made with the expertise of the whole project team. This leads to the final comment concerning the sprint planning. The duration of the sprint planning should be dependent on the number of tasks and decisions for the upcoming sprint. Hourly sprint planning is rather short for planning and decision making. On the other hand, meetings should not be comprehensive to keep their effectiveness (Luong & Rogelberg, 2005).

Next to the sprint planning, the sprint review of the CUAD scum framework should be modified. In the original CUAD framework, the review is to be held with the stakeholder(s) after every sprint. The pilot study has shown that this is not strictly necessary. Stakeholders should be consulted if a presentable concept is made. Fragmented parts of the concept or the decisions making process do not improve the communication with the stakeholder(s), rather the opposite. But it has to be emphasised that a presentable concept is not a finished product. Nevertheless, sprint reviews are essential to meet, among other things, the conditions of transparency.

ROLES

Analysing the roles of the CUAD framework the conclusion can be drawn that it is first of all important to keep all the tasks of the four scrum roles and, secondly, that none of the conditions has to be modified for the scrum roles. However, the responsibilities of the roles of the scrum master and product owner can be shifted. For small projects and project teams, the role of the product owner and scrum master can be combined. For CUAD, it is important that a vision is guaranteed, stakeholders are included, and context specifications have to be considered. It is, therefore, necessary that at least one team member takes these tasks upon himself. It depends on the scope of the project and the number of team members if the role of the scrum master and the product owner can be combined or not.

ARTEFACTS

The last element of the CUAD framework contains the artefacts and should be modified to incorporate the conditions, inclusion of context, through the product backlog. The product backlog is one of the most important items of the CUAD framework. The product backlog shapes the CUAD vision through incorporating ReSOLVE strategies in the project and emphasises the inclusion of politics. The CUAD framework also states that context variables should be included.

The CUAD framework designed for the pilot study did not implicitly steer on the constraint of time in projects. The pilot study, however, has shown the importance of time constraint in area development projects, which can also be found in the literature concerned with agile project approach. The product backlog of the CUAD framework should emphasise the time constraint through considering time in the prioritisation of the tasks. A useful tool to quickly analyse the activities is to examine the goals and deliverables based on their impact versus their effort. Effort can, for example, characterise the time spent or money spent to fulfil the task.

7.3 THE FINAL CUAD FRAMEWORK

The CUAD framework facilitates the transition to CUAD by incorporating conditions for circularity and the elements of the scrum method. These conditions have been based on literature study concerned with circularity in the built environment and UAD elements and the case studies (see Chapter two and four). The findings of the pilot study resulted in refinement of the CUAD framework. Table 15 describes the final CUAD framework in which the elements of the scrum method incorporate the conditions for circularity. A visual representation of the CUAD framework is shown in Figure 16.

TABLE 15- DESCRIPTION OF THE FINAL CUAD FRAMEWORK

CONDITIONS FOR CIRCULARITY	ELEMENTS OF THE SCRUM METHODOLOGY		
	EVENTS	ROLES	ARTEFACTS
1. ADAPTABLE PROCESS	1. Iterative development through sprints with feedback moments with stakeholders. 2. Sprint duration can differ based on the tasks. 3. No daily scrum meeting exist.	The sprint respective evaluates the roles and responsibilities of the team members to improve collaboration.	Adaption to the product backlog after every sprint.
2. INCREMENTAL TRANSITION	Development of an area occurs through sprints. A sprint delivers a presentable but not finished project/design.		All tasks done are shown and communicated through the increment.
3. NEED FOR GUIDING		The process of development is guided by the scrum master (or scrum master/ product owner).	The product backlog requirements ensure CUAD vision.
4. TECHNICAL KNOWLEDGE		Include technical knowledge by incorporating consulting engineers and contractors in the development team.	
5. TRANSPARENCY	The development of the area is communicated with the stakeholders through the sprint review.		All work done is continuously updated and communicated by the development team through the (online) scrum board.
6. VARIETY OF INVOLVED STAKEHOLDERS	The sprint planning entails decisions making with the input of the whole development team.	1. The product owner guarantees the interest of the stakeholders. 2. The development team is a multidisciplinary team which entails both engineers as architects. 3. The development team can change according to the sprints/phases of the project.	
7. CHANGING ROLES AND RESPONSIBILITIES		1. Four roles have to be divided among the project team of CUAD projects which are the (stakeholders) client, the product owner, the scrum master and the development team. 2. At least one person needs to be responsible for the	

			process of development, the CUAD vision and the interest of the stakeholders without being involved in substantive tasks. 3. Roles division is depended on the level of CUAD, area or singe building.	
	8. CUAD (ACTORS/ ACTIVITIES) OVERVIEW	At the kick-off, an overview should be made of the relevant parties and people in the project team.		Items of the product backlog and the sprint backlog should consider all relevant activities and actors for the whole life cycle of the item.
	9. VISION DEVELOPMENT	1. During the kick-off, the CUAD vision for the area or building project is selected. 2. The CUAD vision is selected according to the ReSOLVE strategies (see condition 12).	1. The responsibilities of the product owner guarantee CUAD vision. 2. Get contractors with CUAD perspective by invoicing CUAD vision in the procurement.	The CUAD vision is incorporated into the product backlog and shapes the outline of the development.
	10. PROFITABLE BUSINESS SCENARIOS		The product owner ensures the interest of the client to create a profitable project.	1. Financial requirements of the client are incorporated in the product backlog as boundary conditions. 2. Prioritisation of the product backlog should (also) be focused on cost (resources).
	11. INCLUDE POLITICS	Go/no-go moments should be incorporated in the sprint events, they should be a part of (some of the) the sprint planning.		The product backlog should include politics in the tasks (items) by appointing go/no-go moments and risk analysis.
	12. RESOLVE STRATEGIES	During the kick of the CUAD vision is determined. The CUAD vision is based on the ReSOLVE strategies.	The product owner guarantees the implementation of the ReSOLVE strategies through the CUAD vision.	The ReSOLVE strategies are the foundation of the CUAD vision, which is guaranteed by the product backlog.
	13. INCLUSION OF CONTEXT	1. During the kick-off, the objectives and the scope of the development are determined. 2. During the sprint planning time, resources and dedications of the project team should be established.		1. Task on the product backlog should consider the context conditions established by the objective and the scope of the project. 2. It is often useful to prioritise the product backlog through the time constraint or duration of the development.

SOURCE: (OWN WORK)

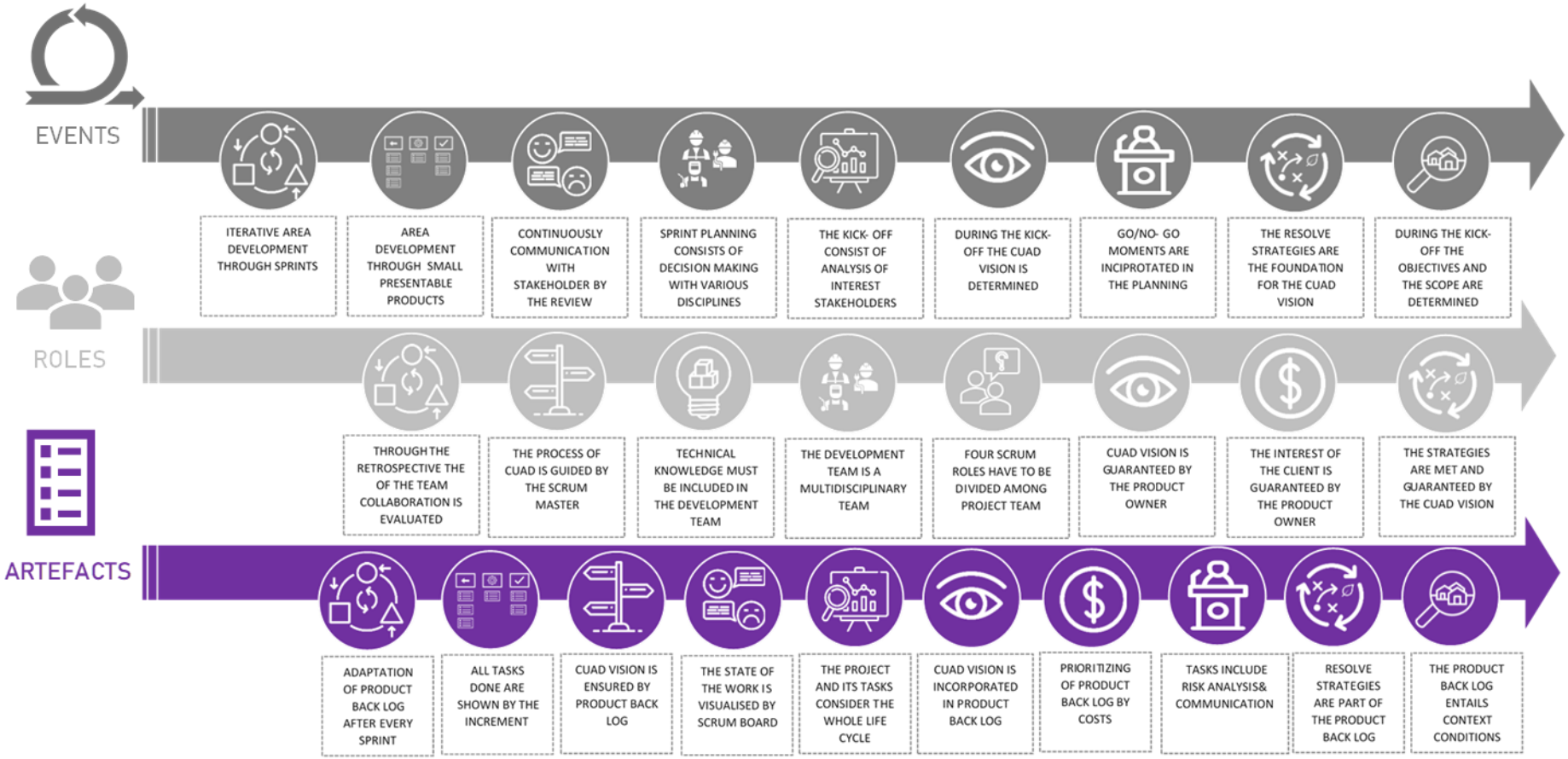
7.4 CONCLUSION

As Table 15 demonstrates, most of the designed conditions for circularity have been met by the pilot study. Nonetheless, one of the most important restrictions of the pilot study, which is time, has not been incorporated in the conditions for circularity. The final CUAD framework therefore incorporates time. The time constraint influences various aspects of the CUAD framework. Time is considered throughout the whole project by condition inclusion of context in the product backlog. This should be done by incorporated time or the time constrains as a requirement of the product backlog.

In addition to the conditions, the elements of the CUAD framework have been adapted. All three element: roles, event and artefact, has been modified. Some modifications, such as including the time constraint, has an effect on both the events as the artefacts. The product backlog, for example, should consider the time when prioritising tasks. Moreover, during the first sprint planning an analysis of the time and resources of the development team should be made. Next to the events and the artefacts, the roles of the CUAD framework are modified for the final CUAD framework. The pilot study has shown that not all development processes need both a scrum master and a product owner. In some cases, the responsibilities of scrum master and product owner can be shared.

The final CUAD framework facilitates the transition to CUAD by incorporating the conditions for circularity developed by this research. The framework enhances incorporating circularity by developing a process outline for an area or building in which a circular vision can be established through incremental and adaptable development with a variety of stakeholders. Table 15 describes the final CUAD framework and Figure 16 is a visual representation of this framework.

FIGURE 16- VISUALIZATION OF THE CUAD FRAMEWORK



SOURCE: (OWN WORK)

8. CONCLUSIONS, DISCUSSION AND RECOMMENDATIONS

SOURCE: (OWN WORK)

This Chapter focuses on the conclusions and recommendations of this research. First, conclusions based on the results related to the sub-questions are discussed. Then, the main research question is answered in Paragraph 8.1. In Paragraph 8.2, the limitations of the research and the relevance of the research are addressed. In the last Paragraph, recommendations for further research and practitioners are presented.

8.1 CONCLUSIONS

The objective of the research was to examine which process strategy for the development of M4H can facilitate the transition to CUAD. The process strategy for the transition to CUAD was examined by answering the following main research question:

What type of process strategy can facilitate the transition to circular urban area development of M4H?

Following previous research, the present study showed the need for a practical strategy or framework for the transition to CUAD (Prendeville, Cherim and Bocken, 2018). The present study aimed to develop a framework that facilitates the transition to CUAD and to test this framework through a pilot study.

The research consisted of three phases. Each phase focused on a different research instrument: literature study, case studies and a pilot study. Through these studies, the sub-questions of the research were answered. The literature study and the case studies together provided an answer for the first three sub-questions. The last sub-question was answered through the results of the pilot study. The main research question was answered by clarifying the sub-questions.

With respect to the first sub-question, the following is concluded:

I. What is circular urban area development?

CUAD is still an undefined concept. Research on circularity in the built environment is often focused on either single building projects or urban metabolism as a whole. The concept of CUAD is described through both the circular construction process of Platform CB'23 and the applied circular strategies. In this research, the concept of the circular construction process of Platform CB'23 is defined as "*An iterative and interactive process in which the building phases do not have a fixed beginning or end. Each phase of the circular building process affects the other phases. Stakeholders of the circular construction process should anticipate on the current and future stages of the process as much as possible*" (Platform CB'23, 2019, p. 12). Furthermore, the circular strategies are based on the strategies of the ReSOLVE framework of the EMF. The ReSOLVE strategies are Regenerate, Share, Optimise, Loop, Virtualise and Exchange (Ellen MacArthur Foundation, 2015b) Thus, this research examined CUAD through the analytical framework, which combines the ReSOLVE strategies with traditional UAD elements.

From the case study, it can be concluded that the circular strategies applied in the cases can indeed be classified as CUAD strategies, according to the ReSOLVE framework. The Share-strategy, for example, can be applied to the process of CUAD, the actors involved in CUAD and the content or technical aspects of CUAD. From the analysis of the cases studies focussed on the process of CUAD, it can be concluded that the Share-strategy can be pursued by including politics, by appointing go/no-go decision moments in the development. Whereas the Share-strategy for content aspects can be pursued by applying share facilities like PSS elevators. Furthermore, from the case studies, the following definition of the concept of CUAD is drafted: "*A development process which entails various projects in which knowledge is created, and the lifecycle of a material, building or urban area is taken into account upfront".*

The second sub-question is related to the approach of traditional UAD and CUAD:

II. What are the differences between the traditional UAD and CUAD?

Traditional UAD is described according to the theory of Franzen, Hobma, De Jonge and Wigmans (2011). Franzen and colleagues developed a well-known and widely used model for UAD. This traditional model consists of five elements: the process, the context, the actors, the content and the policy documents. The traditional model for urban area development can be defined as a top-down

steering model and is mainly focused on 'command and control'. In the traditional model, decisions are often made by public authorities through a fixed land-use plan. The process of traditional UAD is seen as a static and linear project approach. Furthermore, stakeholders are often not included in the decision-making process. Various studies argue, however, that the traditional model is not efficient for current development processes due to the increasing complexity of area development (Franzen, 2011; Wolting, 2006; de Zeeuw, 2007).

In the present research, CUAD is defined as a development approach which incorporates a variety of actors in a network construct (rather than as a linear top-down hierarchical construct). The analysis of Binckhorst and Park 20I20 demonstrated that CUAD demands a multidisciplinary approach that takes this variety of stakeholders into account. Moreover, the transition to CUAD has to be flexible and adaptive. Both the circular construction process of Platform CB'23 and the case studies have indicated that the transition towards circularity is best served through an iterative and interactive construction process in which learning occurs by sharing knowledge and via feedback moments.

Based on the strategies for CUAD, which are based on the ReSOLVE strategies and lessons learned from the case studies, the conditions for circularity were examined through sub-question three:

III. What are the conditions for the process strategy for the transition to CUAD?

Through this research, the conditions for the process strategy for the transition to CUAD, which can be referred to as the conditions for circularity, were distinguished. These conditions were developed from the analysis of what CUAD is and from the requirements for the transition to CUAD. The requirements for transitions to CUAD are defined as the lessons (to be) learned. The analysis of the conditions is based on the literature study and case studies.

The literature study and the case studies indicated that the transition to CUAD requires an adaptable and flexible development process with a multidisciplinary perspective. This need entails that the perspectives of various stakeholders have to be taken into account. Furthermore, the literature study and the case studies indicated that CUAD needs a vision, or dot on the horizon, which could be defined by the ReSOLVE strategy. Also, the CUAD vision should be guided by the initiating party. In total, 13 Conditions were derived from the literature and case study analysis that together form the parameters for CUAD. These 13 main conditions are: include politics, vision development, adaptable process, profitable business scenarios, incremental transition, information sharing/transparency, CUAD (actors/activities) overview, the inclusion of context, guiding the process, changing roles and responsibilities, include ReSOLVE strategies, technical knowledge and variety of involved actors.

The final sub-question of this research related to the development of the framework. This fourth sub-question was formulated as:

IV. How should the process of CUAD be designed?

CUAD requires an iterative, rather than linear, process approach that is adaptable to change. Furthermore, the process of CUAD needs a wide variety of stakeholders and perspectives to be active early in the process. From this analysis of the development approach for CUAD, it is concluded that an agile approach could fit CUAD. The main reason for looking at agile methodology is that this methodology aims to incorporate changes by emphasising adaptability and by focusing on developing the scope step-by-step. After examining the different agile methods and their accompanying tools (Satpathy, 2013; Streule, Miserini, Bartlome, Klippel, & Garcia de Soto, 2016), it is concluded that the scrum-methodology could fit the development approach of CUAD.

The scrum-methodology includes several aspects that could facilitate a circular process strategy. The conditions for circularity, adaptability and incremental transition are met through iterative sprints. The inclusion of a variety of perspectives is met through a multidisciplinary development team. Lastly, the conditions related to guiding the process are met by including a scrum master. The scrum master guides the process. In addition to adaptability, incremental transitions, variety of stakeholders and guiding the process, the scrum-methodology also meets the other

conditions for circularity: profitable business scenarios by value-prioritisation of the product backlog, information sharing/transparency by the first principle of empirical process control which is focussed on transparency and openness, changing roles and responsibilities by incorporating scrum roles and responsibilities and vision development by the project outline of the product backlog.

Through the four sub-questions, the main research questions can be answered:
What type of process strategy can facilitate the transition to circular urban area development of M4H?

The present research concludes that the process strategy needed for the transition to CUAD is defined by the CUAD framework. The CUAD framework is a practical tool developed through the present research to facilitate the transition to CUAD. The CUAD framework has adapted the original scrum-methodology from the IT-sector to fit the conditions of circularity and facilitates the transition to CUAD by emphasising an incremental and adaptable development process.

The CUAD framework entails a process strategy that is better equipped to incorporate future insights and inventions, as a circular building is still in its infancy. Moreover, instead of relying on a fixed land-use plan, the development of CUAD occurs through a general vision or point on the horizon. This point on the horizon is, in terms of circularity, based on the ReSOLVE strategies for the built environment of the EMF. The CUAD-vision is the main objective of CUAD and is being pursued by incremental and iterative development. This incremental development is done by translating the CUAD-vision, or the objective of the area, into concrete tasks or actions. CUAD adapts to changes through iterative development. Moreover, learning occurs via feedback and evaluation moments.

Furthermore, the CUAD framework entails that the development of an area is done by a multidisciplinary team and that various perspectives and interests of the different stakeholders are taken into account. Next to evaluating the development process with the project team, the development takes the interest of involved stakeholders into account through feedback moments. Additionally, the CUAD framework stresses that both the visions of CUAD and the process of development should be guided and guaranteed. The CUAD framework then incorporates process and vision guidance by designating project members that are responsible for the vision of CUAD and the process of development.

The CUAD framework was tested through a pilot study conducted for the development of M4H. The subject of the pilot study was the development of the masterplan for the Galilei Park in M4H. From the pilot study, it can be concluded that the CUAD framework has successfully facilitated the implementation of CUAD strategies into the masterplan of the Galilei Park. Furthermore, the pilot study was evaluated as successful by both the project team and the client. The success of the pilot was defined, among other things, by a follow-up. Both the concept developed in the pilot study, through the framework for the Galilei Park and the CUAD framework itself will, therefore, be followed through.

Nevertheless, the success of the pilot study does not immediately indicate that the CUAD framework is the most suitable and only tool that facilitates the transition to CUAD. Furthermore, CUAD is an ongoing learning process, which indicates that the CUAD framework can and should be improved and further developed.

8.2 DISCUSSION

This Paragraph discusses the limitations of the research and the relevance of the broader theoretical implications of the empirical findings.

8.2.1 LIMITATIONS OF THE RESEARCH

As mentioned earlier, CUAD is a relatively new and undefined concept. To examine which process strategy facilitates the transition to CUAD, various decisions related to the design of the research were made. The practical and methodological limitations related to these decisions are described next.

PRACTICAL LIMITATIONS

A number of practical limitations are related to constraints of timing and the duration of the case study. Firstly, the case studies were conducted during the summer, mostly in the months of July and August. However, during the summer, many companies in the construction industry are closed. This made it difficult to find sufficient participants for the case studies and has led to an extended duration of the case study research. Secondly, one of the conditions for circularity is the inclusion of a variety of stakeholders. Due to the time constraints of the pilot study, the actual designers of DELVA were not included. Moreover, the technical and environmental expertise of the development team was obtained from within the PoR Authority. The pilot study, therefore, only tested the collaboration between different disciplines and not between different parties involved in CUAD.

METHODOLOGICAL LIMITATIONS

Various methodological limitations of the literature and pilot studies can be distinguished. The literature study on CUAD is mainly focused on how the literature describes CE in the built environment and on traditional UAD. One of the limitations of defining CE in the built environment is related to the definition of the CUAD process. According to this research, CUAD is focused on the circular construction process as defined by Platform CB'23. However, the question arises if the circular construction process of Platform CB'23 should actually be the foundation for the development of a new process framework because the circular construction process of Platform CB'23 is still being improved and adjusted.

Concerning the literature on UAD, two fundamental limitations can be distinguished. First of all, one single theory or school of thought is chosen by this study as the reference point for describing traditional UAD. The choice of different UAD theories, such as related to organic development of urban areas, can lead to different focus points or other definitions of the concept of CUAD. Secondly, this research defines UAD as a combination of interrelated project and process approaches. Some authors, however, imply a clear distinction between these approaches (de Bruijn, Ten Heuvelhof, & In 't Veld, 2003).

The subject of the pilot study is the development of the master plan of the Galilei Park in M4H. CUAD is being pursued by implementing circular principles of M4H in the development of the area. It is unclear if the pilot study is representative of CUAD in general, as urban area development is always dependent on specific spatial, political and economic contexts.

Moreover, the present research does not define different types of CUAD, because CUAD should fit the context of the area, and will therefore never be completely comparable. However, the question still remains whether a classification of CUAD types can be made.

8.2.2 RELEVANCE OF THE RESEARCH

The relevance of the present research consists of the contribution to science, as well as the similarities and differences of the present findings with the existing literature. Examining the contribution to science, the assumption can be made that this research is the first to define the concept of CUAD. This study describes the concept of CUAD through a general definition and through the strategies that can be applied. Currently, not one general definition of CUAD is provided by the literature. Secondly, the present research has created a hands-on tool for (C)UAD. Thirdly, through this research, a new development approach for the process of (C)UAD was constructed. This research has developed the CUAD framework that facilitates the transition to CUAD by adapting the original scrum-methodology from the IT-sector to fit the conditions of circularity.

Comparing the present study with the existing literature, it can be noted that not many studies so far focused on macro-level circularity in the built environment. An exception is the study of Prendeville, Cherim and Bocken (2018). In this study, Prendeville and colleagues discuss the circularity of the built environment of Rotterdam. Based on the findings of Prendeville, Cherim and Bocken (2018), it can be

concluded that Rotterdam is actively implementing CE in the built environment, whereas the present research has indicated that actual implementation of CE in the built environment has not occurred yet. An explanation for this discrepancy is that most of the strategies and actions mentioned by the study of Prendeville, Bocken and Cherim (2018) are related to energy flows or (bio)waste flows instead of construction flows.

Furthermore, the present research states that practical implementation or practical strategies are missing. This lack of practical implementation is consistent with the findings of Prendeville and colleagues (Prendeville, Cherim, & Bocken, 2018). Which states that “the city of Rotterdam aims to increase CE in Rotterdam by motivation through visibility.”. Through this visibility, the municipality of Rotterdam hopes to motivate other parties in the area to find creative ways to generate new value (Prendeville, Cherim and Bocken, 2018, p. 181). Their research argues that further research should focus on analysing the tools and methods that provide city managers with a guideline on how to holistically implement CE in cities.

8.3 RECOMMENDATIONS

8.3.1 RECOMMENDATION FOR FURTHER RESEARCH

Various areas of further research can be pointed out through the innovative and complex concept of CUAD, and because UAD and the construction industry are (somewhat) unfamiliar with the scrum-methodology. Two areas for further research are discussed. These areas have to do with the application of the CUAD framework and the development of the CUAD framework.

One of the first questions that arise is whether the CUAD framework can be applied to more aspects of developing urban areas. The pilot study has brought forward the assumption that the CUAD framework could be applied to various complex area development processes. Indeed, the CUAD framework was shown to be useful for complex and unknown phenomena, but the question remains if it can also improve other aspects of UAD.

Next to the extended approach of the CUAD framework, the question can be asked if the CUAD framework can be generalised. The pilot study has been successful for the master plan of the Galilei Park, but the outcome of a pilot study cannot be generalised scientifically (van Teijlingen & Hundley, 2001). The last recommendation for research into the application of the framework is related to the participants and stakeholders. The CUAD framework focuses on the development of areas which involve parties through contracts. However, the development of urban areas also consists of negotiation about which developer gets which lot. The question, therefore, arises whether the CUAD framework can be applied to the negotiation aspect of CUAD.

Next to recommendations for applying the CUAD framework, several questions can be raised concerning the development of the CUAD framework. This research emphasised, for example, a simplified version with four leading scrum roles. The pilot study showed that it could be beneficial to change the number of people who take on the responsibilities of the roles while keeping the number of scrum roles steady. If, for example, a project has many stakeholders with different perspectives, would it then be preferable to have more than one product owner? Further research focusing on the number of roles and the size of the scrum team could improve the CUAD framework. For instance, a study which focuses on the number of people who take on the scrum master role and the product owner role could answer these questions.

8.3.2 RECOMMENDATIONS FOR PRACTITIONERS

The objective of this research is to facilitate the transition to CUAD by developing a hands-on tool. This tool, or framework, is called the CUAD framework. The CUAD framework facilitates the incorporation of CUAD strategies in urban development. The following recommendations for practitioners describe how the CUAD framework can be implemented in CUAD projects such as the development of the masterplan for the Galilei Park. The recommendation for practitioners, therefore, aims to indicate when the CUAD framework should be applied, by explaining the purpose of scrum and of how scrum should be applied through the methodology.

PURPOSE

- The CUAD framework should be applied in complex, unfamiliar and uncertain development of incorporating circular strategies in UAD.
- To be able to fit the CUAD framework in the (traditional) project approach of the organisation, the CUAD framework should be seen as a process framework for developing and designing projects. It then fits with the delivery process of the PRINCE2 methodology. PRINCE2 is a commonly used traditional project management methodology in organisations (Wideman, 2002). PRINCE2 is also incorporated in the organisation of the PoR Authority. A short description of PRINCE2 can be found in Chapter five.
- Developing or deciding upon the CUAD vision should be done at the start of a project during the initiation phase. For the macro-level, this entails that the CUAD vision should be developed for the masterplan. For a single building project, it entails that the CUAD vision should be developed through the CUAD framework before the tender. The development process could then result in conditions for the tender. However, the CUAD framework can also be applied in further development and design of the building.

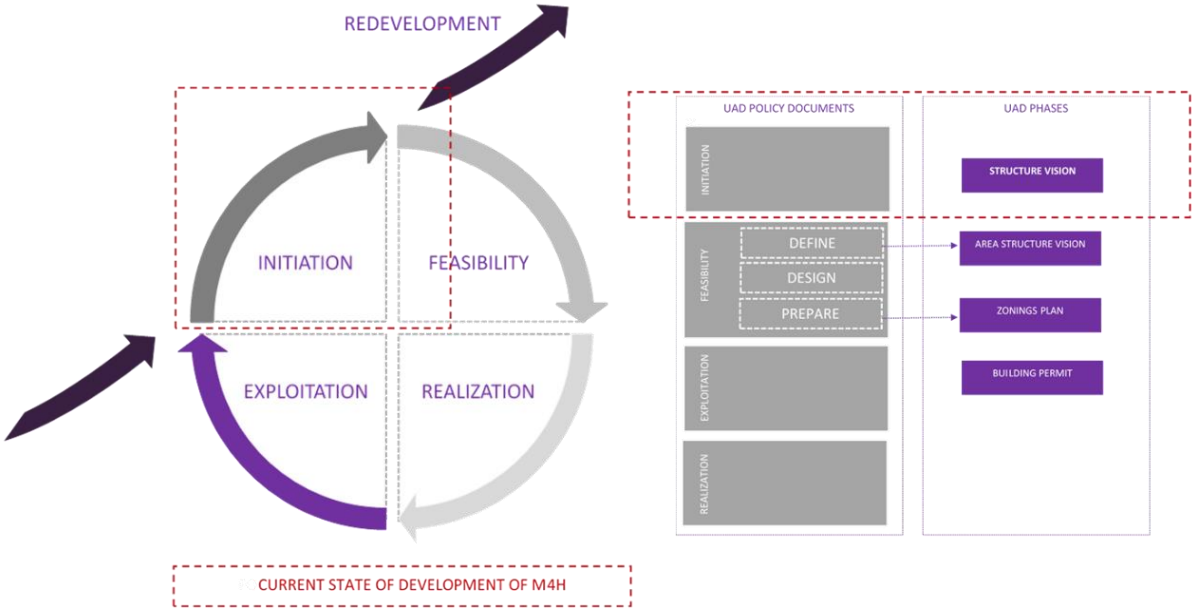
METHODOLOGY

- To incorporate the CUAD framework in a development of an area or building, three steps have to be taken before the actual framework can be applied to the project. First of all, the level of implementation has to be decided (building or area focus). Then, based on this decision, the product owner, client and scrum master are established. The third step is to ensure the project team is knowledgeable about, for example, through a scrum workshop.
- The CUAD framework consists of three elements: events, roles and artefacts. The components of the elements, their definitions, and how to apply them are described in the previous Chapters and in Chapter five and six.
- It should be emphasised that the CUAD framework is still in development. This entails that CUAD should fit the context in which the framework will be applied. Moreover, feedback or evaluation moments are necessary to ensure the learning process of CUAD and the CUAD framework.

8.3.3 Recommendations for the Rotterdam Makers District

To incorporate the CUAD framework in the development process, the current state of the area should be known. The current state of the affairs of the context is leading in implementing the CUAD framework. The process of developing M4H has completed the initiation phase. The council has approved the "Ruimtelijk Raamwerk" (structural vision) of the municipality of Rotterdam. Figure 17 shows the current state of the development of M4H in the circular area construction process. Nonetheless, in reality, the phases are not strictly separated. For instance, some projects are already under construction, such as the TP warehouses.

FIGURE 17- CURRENT STATE OF THE DEVELOPMENT OF M4H



(SOURCE: OWN WORK)

To incorporate the CUAD framework into the area development of M4H, a roadmap is made. However, different paths can be followed. The chosen path (2a or 2b) depends on the current state of the development of the area. The current state of development can be a general circular vision for M4H, which can be defined as the eight circular principles of M4H. Alternatively, a CUAD vision exists that is not yet defined into concrete actions or plans. The goal of the CUAD process is to create a CUAD vision for the area and to translate the vision into a master plan of the area and/or into concrete project plans.

1. Determine the product owner and scrum master for the area development process. The scrum master and the product owner should be knowledgeable about the scrum methodology. The product owner and scrum master should be chosen from members of the developing party. For instance, for the development of the Galilei Park, this developing party is the PoR Authority.

2. During the kick-off, the objective of the project is determined.
    a. If a concrete CUAD vision is lacking and the client (the municipality of Rotterdam or the PoR Authority) does not possess enough knowledge about circularity in the built environment, a circular/environmental consultant should participate in the kick-off. During the kick-off, a concrete vision is selected based on (one of) the eight principles of circularity of M4H.
    b. If a concrete CUAD vision exists, kick-off should occur with the product owner, the scrum master and the client. For example, for the development of the Galilei Park, it was determined that the focus of the CUAD vision should be on valuing residual flows.

3. Through the objective of the development, which is determined during kick-off, the development team is compiled. The team is built by the product owner and the scrum master. The development team should encompass different disciplines of area development, including engineers, architects and area managers (planners).

4. The objective of the area development project is translated and carried out by the development team during sprints. During the first sprint, planning agreements about the method of working have to be established. This entails agreements on the duration of sprints, the timing of feedback moments, and the method for the documentation of work. An elaborated description of how development occurs due to sprints can be found in Paragraph 5.3 and Paragraph 7.2.

5. The results of this development process are a masterplan or a project plan which incorporate the CUAD vision. The result of the CUAD project can be seen as the programme of requirements (Dutch: Programma van Eisen (PVE)) according to the traditional project management of the PRINCE2 approach (Wideman, 2002).

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APPENDIX

TABLE OF CONTENT APENDIX

A. CIRCULARITY IN THE BUILT ENVIRONMENT

A1. DRIVERS AND BARRIERS FOR THE TRANSITION TO THE CIRCULAR ECONOMY

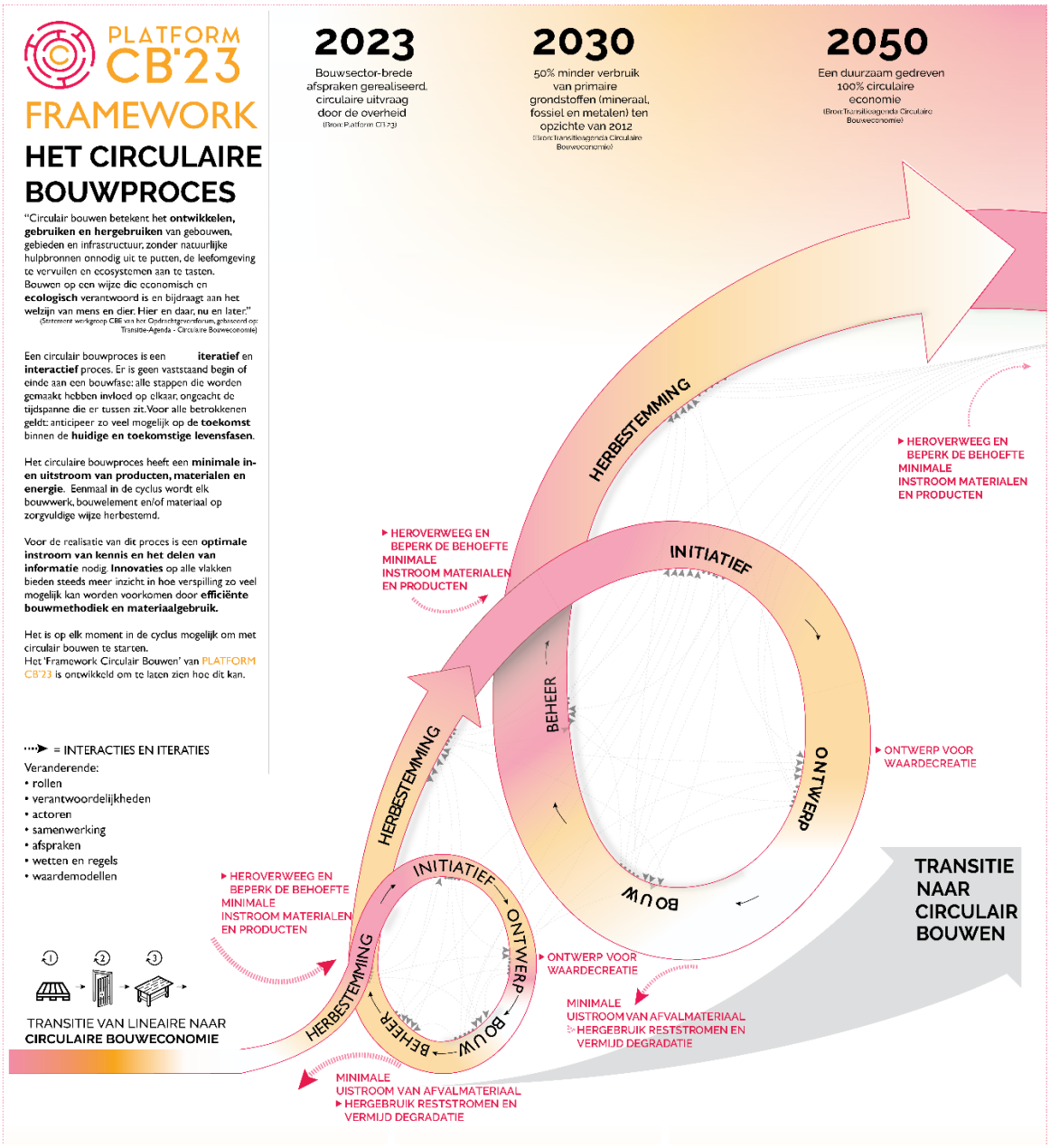
Table A1: Drivers and barriers for the transition to the circular economy

	DRIVER	BARRIER
Environmental	Resources constraints and potential for negative environmental impacts	
Economic	Potential for improving cost efficiency, finding new revenue streams and gaining profit Potential for new business development, innovation and synergy opportunities	High costs and lack of financial capability and support Lack of tools and methods to measure (long-term) benefits of CE projects
Social	Increased internationalization and worldwide awareness of sustainability needs Potential to increase workplaces and vitality	Lack of social awareness and uncertainty of consumer responsiveness and demand Lack of market mechanisms for recovery Lack of clear incentives
Institutional	Directing regulations and standard requirements Supportive funds, taxation and subsidy policies	Complex and overlapping regulation Lack of governmental support Lack of CE know-how of political decision-makers
Technological and informational	Potential for improving existing operations New technologies Increased information sharing through enhanced information management technologies, e.g. platforms	Lack of information and knowledge Lack of technologies and technical skills
Supply chain	Potential for reducing supply dependence and avoiding high and volatile prices Open collaboration and communication practices Multi-disciplinarily increased the availability of resources and capabilities Management of (reverse) networks	Lack of network support and partners Strong industrial focus on linear models Lack of collaboration and resources
Organizational	Potential for differentiation and strengthening the company brand Increased understanding of sustainability demands Circularity integrated into company strategy and goals Development of skills and capabilities for CE	Incompatibility with existing (linear) operations and development targets Silo thinking and fear of risks Conflicts with existing business culture and lack of internal cooperation Heavy organizational hierarchy and lack of management support Lack of CE knowledge and skills

SOURCE: (TURA, ET AL., 2019)

A2. CIRCULAR CONSTRUCTION PROCESS

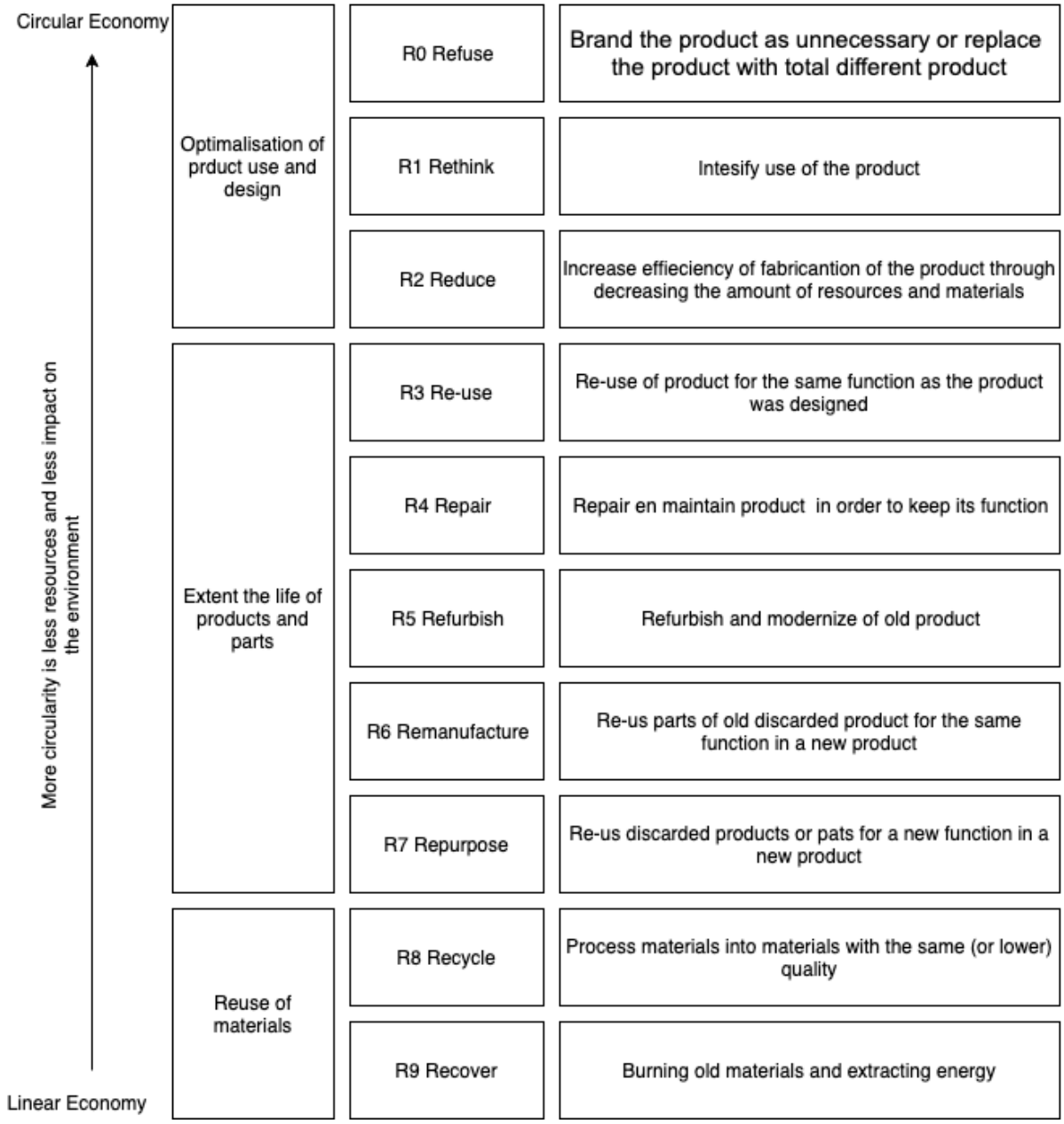
Figure A1: Transition to circular building



SOURCE: (ACTIETEAM PLATFORM CB'23, 2019)

A3. 10R MODEL

Figure A2: 10r model based on 10r model PBL



SOURCE: (ACTIETEAM PLATFORM CB'23, 2019)

A4. THE ANALYTICAL FRAMEWORK

Table A2 The Analytical framework

	REGENERATE	SHARE	OPTIMISE	LOOP	VIRTUALISE	EXCHANGE
CONTEXT	LAW ON REUSE OF LAND		PROFITABLE BUSINESS MODEL PER SECTOR		OPEN DATA SOURCES	
CONTENT	LAND RESTORATION	PRODUCT AS SERVICE SYSTEM (PSS)	INDUSTRIAL PROCESS SMART URBAN DESIGN MATERIAL EFFICIENCY	OPTIMIZATION OF END-OF-LIFE OF THE BUILDING/MATERIALS MODULARITY OF THE BUILDING REMANUFACTURING OF MATERIALS	SMART APPLIANCES	
PROCESS		OPENNESS/ TRANSPARENCY	SPEED IN PROCESS FLEXIBLE PROCESS PROTECTION VALUES ACTORS	ITERATIVE PROCESS	VIRTUALISATION OF PROCESS	
ACTORS		CO-HOUSING OFFICE-SHARING RESIDENTIAL SHARING	VARIETY OF STAKEHOLDERS		TELEWORKING	NEW TYPE OF SERVICES
POLICY DOCUMENTS						

Table A3- Definitions of the CUAD strategies (Network, 2016; Ten Heuvelhof, 2011)

RESOLVE	STRATEGY	DEFINITION
REGENERATE	LAW ON REUSE OF LAND	Policies and regulations which demand/stimulate land restoration
	LAND RESTORATION	Building on brownfield sites and saving virgin land
SHARE	PRODUCT AS SERVICE SYSTEM (PSS)	Instead of buying and disposing of products/buildings/houses, the product is "rented". A building or part of the building is rather a service than a product (Mont, 2002).
	OPENNESS/ TRANSPARENCY	Process and decisions made during the UAD process should be shared between stakeholders of the UAD process
	CO-HOUSING	Sharing residential facilities like a kitchen or bathroom.
	OFFICE-SHARING	Sharing offices between different companies/institutions
	RESIDENTIAL SHARING	Peer-to-peer renting
OPTIMISE	PROFITABLE BUSINESS SCENARIOS	A general model per sector which illustrates how the transition from linear to circular can be beneficial for the sector
	INDUSTRIAL PROCESS	Off-site production and prefabrication of materials
	SMART URBAN DESIGN	Integrated urban design with participant urban development. High-quality urban environments and compact urban growth.
	MATERIAL EFFICIENCY	Material which is renewable, recyclable, non-toxic etcetera
	SPEED IN PROCESS	Process of transition to CUAD should make progress. Rather make small decisions than wait long without any progress.
	FLEXIBLE PROCESS	Process and decisions should not all be fixed. The process should be adaptable to fit the complex environment
	PROTECTION VALUES ACTORS	The actors and their values should be considered. Decisions should not solely be made top-down
	VARIETY OF STAKEHOLDERS	Various stakeholders and their perspectives should be considered for the multidisciplinary approach.
LOOP	OPTIMIZATION OF END-OF-LIFE OF THE BUILDING/MATERIALS	Use materials which can be easily re-used can be disconnected or can go back to the biological or technical cycle.
	MODULARITY OF THE BUILDING	A building should be adapted. Parts can be disconnected, used for another purpose or somewhere else.
	REMANUFACTURING OF MATERIALS	Materials of products should be designed to fit circular though, remanufacturing to C2C certificated materials, for instance.
	ITERATIVE PROCESS	Feedback and evaluation optimise the process through learning (from mistakes).
VIRTUALISE	OPEN DATA SOURCES	Common open data sources for information about new materials, techniques or CUAD activities
	SMART APPLIANCES	Virtualisation through for example smart home systems, light efficiency or connected appliances
	VIRTUALISATION OF PROCESS	Use of software like BIM, digital mock-up of automated maintenance systems.
	TELEWORKING	Communication and collaboration through skype or conference calls and digital platforms
EXCHANGE	NEW TYPE OF SERVICES	Services like multi-modal transport.

B. RESEARCH DESIGN

B1. FIELDWORK

B1.1 General overview fieldwork

Table B1- Fieldwork overview

	ACTIVITY	NAME	COMPANY	DATE
PHASE I	EXPLORATIVE INTERVIEWS	Ronald van der Heijde Mariska Vogel	IABR architecten	06/05/19
		Jos Streng	Municipality Rotterdam	07/05/19
		[redacted]	PoR Authority	02/05/19
		Ernst Ten Heuvelhof	Professor TU Delft	17/06/19
	EXCURSION/ SYMPOSIUM	Excursion Binckhorst	Municipality The Hague	16/05/19
		Project XX: symposium circular economy in the built environment	Boosting	11/06/19
		Symposium: The Future of (no) Waste	Clean Tech Delta	25/06/19
	WORKSHOP	M4H Circulaire gebiedsontwikkeling	[redacted]	01/07/19
PHASE II	CASE STUDIES			
	Binkhorst	Bram Heijkers	I'm Binck	31/07/19
		Gert-Joost Peek	Hogeschool Rotterdam	15/08/19
		Jorinde Corbet	PERSC	01/08/19
		Juliette Verbeek	Municipality of The Hague	21/08/19
		Marie-Jeanne Kleemans	Municipality of The Hague	25/07/19
		Phlip Boswinkel	Local	13/08/10
	Park 20I20	Alex Kragtwijk	IBB Kondor	23/08/19
		Arthur van Dijk	Province of North-Holland (Municipality of Haarlemmermeer	28/08/19
		Jeroen Grosfeld	NO3 Architects	28/08/19
		Paul Rietberg	Reggeborgh Group	26/08/19
		Owen Zachariassa	Delta Development	19/08/19
PHASE III	PRESENTATION	Mini symposium- Het circulaire bouwproces	Het Opdrachtgevers forum	03/10/10

B1.2 Overview case study participants

Table B2: Participants case studies

	NAME	FUNCTION	COMPANY	DATE
BINCKHORST				
	Bram Heijkers	Researcher	I'm Binck	31/07/19
	Gert-Joost Peek	Professor	Hogeschool van Rotterdam	15/08/19
	Jorinde Corbet	Consultant	PERSC	01/08/19
	Juliette Verbeek		Municipality of The Hague	21/08/19
	Marie-Jeanne Kleemans	Applicant	Municipality of The Hague	25/07/19
	Phlip Boswinkel	Developer	Local	13/08/10
				31/07/19
PARK 20I20				
	Alex Kragtwijk	Project manager	IBB Kondor	31/07/19
	Arthur van Dijk	Commissioner of the King (Alderman off Economics affairs)	Province of North-Holland (Municipality of Haarlemmermeer)	15/08/19
	Jeroen Grosfeld	Architect	N30 Architects	01/08/19
	Paul Rietberg	Develop manager	Reggeborgh Group	21/08/19
	Owen Zachariassa	Developer	Delta Development Group	25/08/19

B.2 INTERVIEW PROTOCOL

"TRANSISTION TO CIRCULAR URBAN AREA DEVELOPMENT"

DATUM	
ORGANISATIE	
INTERVIEWER	Nesaneth van Slobbe
GEINTERVIEWDE	

DOEL- *Het doel van de semi gestructureerde interview is om inzicht te krijgen in de implementatie van circulariteit in het proces van gebiedsontwikkeling bij de case studies. Circulaire gebiedsontwikkeling wordt geanalyseerd aan de hand van 13 strategieën ontwikkeld door middel van de gebiedsontwikkeling elementen het proces en de actoren, en door de zes circulaire strategieën van het ReSOLVE framework van EMF.*

INTRODUCTION

- **Interviewer:** Nesaneth van Slobbe, Bsc. Technische Bestuurskunde en Msc. Construction Management & Engineering.
- **Onderwerp**: Circulaire gebiedsontwikkeling met focus op proces.
- **Hoofdoel**: Inzicht krijgen in de strategieën die worden toegepast voor circulaire gebiedsontwikkeling, welke actoren hier voor onontbeerlijk zijn en hoe zij samenwerken.
- **Tijdsduur:** Circa 1 uur
- **Resultaten**: Het interview zal als input dienen voor het creëren van samenwerking tool voor circulaire gebiedsontwikkeling. Dit framework is onderdeel van mijn afstudeeronderzoek en wordt getest aan de hand van een pilot study. Resultaten van dit deel van onderzoek kunt u opvragen. Uitwerking van de notulen van dit interview zal binnen (X) weken gereed zijn.
- **Opname interview**: Mag het interview worden opgenomen? De opname wordt gebruikt voor de wetenschappelijke waarden van het onderzoek.
- **Privacy**: Hoe wilt u geciteerd worden?
- **Introductie geinterviewde:** Kunt u zichzelf (en uw bedrijf) introduceren?

GENERAL QUESTIONS

1. Hoe bent u en uw bedrijf betrokken de ontwikkeling van dit gebied?
2. Wat is uw rol? Waarom bent u (als bedrijf) bij dit project betrokken?
3. Vanaf welk fase bent u (uw bedrijf) betrokken bij het project?
4. Welke fase is het project nu?

CIRCULAR ECONOMY

5. Wat verstaat u onder circulaire economie? En wat verstaat u onder circulaire gebiedsontwikkeling?
6. Hoe werkt uw bedrijf aan circulariteit in de bouw? Welke projecten doet u hierbij?
7. Wat zijn de grootste drijfveren voor circulariteit voor u (uw bedrijf)?

ELEMENT	STRATEGY	
Process		
	Progressie	• Hoe vond u het proces gaan? Liep/loopt het project ongeveer volgens de planning?

		• Hoe vond u de progressie, stond de ontwikkelingen rondom project vaak te langs stil of zat er genoeg snelheid in het project?
	Flexibel process	• Zijn er veel besluiten aangepast gedurende de ontwikkeling van het gebied? Hoe ging het door voeren van deze veranderingen? • Vind u het proces/project in algemeen flexibel/makkelijk veranderbaar?
	Transparant process	• Vind u dat er genoeg transparantie en openheid was over de besluiten en de gebiedsontwikkeling in het algemeen?
	Bescherming kernwaarden	• Hoe worden besluiten in algemeen genomen, door project projectpartners of door meerdere betrokkenen?
	Iteratief process	• Wordt er terug gekoppeld naar eerder besluiten? En worden beslissingen (soms) opnieuw genomen?
	Virtueel process	• Verloopt het proces van gebiedsontwikkeling van deze case anders dan andere gebiedsontwikkeling processen? • Wordt er gebruik gemaakt van nieuwe proces methodes en/of digitale modellen om processen te verbeteren? (BIM)
Actors		
	PSS	• Is er in het project PSS toegepast of over gediscussieerd om bouw projecten als services i.p.v. producten/assets? ?
	Co-housing Office-sharing Residential sharing	• Wordt er in de ontwikkelingen begrip van deel-faciliteiten meegenomen?
	Variety of stakeholders	• Wie zijn hoofd betrokken bij project/ de project partners? • Welke partijen waren/ zijn veel betrokken bij het project die buiten de groep van projectpartners vallen? • Welke partijen spelen volgens u belangrijke rol bij circulaire gebiedsontwikkeling ? • Wat zijn de verantwoordelijkheden van deze partijen?
	Teleworking	• Hoe hebben de partijen samengewerkt om transitie naar circulaire gebiedsontwikkeling te verwezenlijken? • Hoe wordt er gecommuniceerd tussen de partijen? Is er veel spraken van telewerken? (skype/ afstandsvergaderingen)
	New type of services	• Zijn er ook andere soort partijen dan de standaard bouw partijen (project ontwikkelaar, consultant, engineer, aannemer & woningcorporatie) bij het project betrokken zoals sloop partijen?
CONTENT		
	Land restoration Industrial process Smart urban design Material efficiency Optimization of end-of-life of the building/materials Modularity of the building Remanufacturing of materials	• Hoe is circulaire strategie in dit project tot stand gekomen? • Welke strategieën m.b.t. circulariteit zijn toegepast binnen dit project en waarom? • Welke barrières komt u tegen bij het implementeren van circulariteit in de bouw en van deze strategieën in dit project? • Wat zijn de drijfveren voor transitie naar circulaire gebiedsontwikkeling volgens u? • In welke maten hebben deze barrières/ drijfveren te maken met het proces en/of de ander partijen/actoren?

	Better-performing materials	

CLOSING

- Zijn er nog vragen/opmerkingen die ik niet heb gesteld en die u graag wilt vertellen?
- Heeft u nog verdere opmerkingen en/of vragen?

Bedankt voor uw tijd!

C. CASE STUDY RESULTS

C1. BINCKHORST

C1.1 CUAD STRATEGIES APPLIED

Table C1: CUAD strategies of the Binckhorst

	REGENERATE	SHARE	OPTIMISE	LOOP	VIRTUALISE	EXCHANGE
CONTEXT		Participation agreement	CO2 emission regulations BetonAkkoord			EPA
CONTENT	Heat/cold storage	Shared facilities Binck Blocks		Reuse buildings Water fences		
PROCESS		Wijksafari Ronde tafel First date(s)		Revaluation milestones		
ACTORS		We think Binck	Linking people, knowledge and networks (I'm Binck)			
POLICY DOCUMENTS						

Table C2: Description of the CUAD strategies of the Binckhorst

CUAD STRATEGY	DESCRIPTION
Heat/cold storage	Transforming the Drinkwater basin in the area in a heat/cold storage.
Participation agreement	Law of the municipality of The Hague which implies that resident should be engaged in the development of the area
Shared facilities Binck Blocks	Binck Blocks is designed with several common areas. Binck Blocks should create a community "Buurschappelijk"
Wijksafari	Roundtrip around the neighbourhood and to get to know the area and the inhabitants.
Ronde tafel	Meeting with all involved stakeholders/entrepreneurs
First date(s)	An event in which people (new inhabitants) can get familiar with Binckhorst and Binck Blocks.
We think Binck	We Think Binck is a joint venture of market parties involved in the redevelopment of Binckhorst in The Hague.
CO2 emission regulations	The national and European regulations on decreasing CO2 emissions
BetonAkkoord	The BetonAkkoord is a sector-wide agreement which aims to make concrete more sustainable
Linking people, knowledge and networks	Circularity is not only related to linking material flows but also about bringing people and knowledge together
Reuse buildings	The old Caballero Factory and other old industrial building have gained new uses/destinies.
Water fences	The garden of the “mansions” have fences that collect the rainwater.
Revaluation milestones	Development is of the Binck Blocks is evaluated after every milestone. Changes in the development process are made through the evaluation
EPA	The pilot for the Environmental Planning Act

C1.2 LESSONS (TO BE) LEARNED

Table C3: Lessons learned from Binckhorst

	POSITIVE EXPERIENCE	NEGATIVE EXPERIENCE
ECONOMIC	Profitable business models Integrated business models Intention	Not profitable (hub) Scale demand(not profitable) Lack of knowledge cost& benefits Double agenda (land municipality)
ENVIRONMENTAL		
INSTITUTIONAL	Council agreement (municipality) Focus point and responsibilities Including flexibility with (Ruimtelijk Raamwerk/ Reservation system/ simple rules) Rules& regulation decrease uncertainties EPA (integral working) CE through responsibilities for market focus points/ measurements	*Need for transition CE* *Division of knowledge* Changing alderman/ board/ politics *Lack of knowledge about CUAD* *Concept without conditions* Roles/ responsibly division (share/services) Participation is lacking Increasing policy through EPA Reservation system cause double work EPA and the reservation are too big steps in once An increasing number of contracts (example separating waste
ORGANIZATIONAL	One overarching party	
SOCIAL	Successful examples (tangible) Urgency Selling the character of the area Information sharing Participation inhabitants	Becoming a concept/market strategy
SUPPLY CHAIN/MARKET	Placemaking/ Character of the area Efficiency Urgency One general developer Multiple/integrated performance Steering through procurement	Lack of knowledge Public responsibilities (municipality) Lack of trust market Lack of knowledge activities whole area Uncertainties/risks Too much responsibility developer Real estate market (the difference between developer and investor)
TECHNOLOGICAL		The short duration reservation system Context-specific applying CUAD

Table C4: Roles and responsibilities of the involved actors of CUAD for Binckhorst

ROLES	RESPONSIBILITIES
MUNICIPALITY	• Steering/demanding innovations (through rules and regulations) • Rules for quality • Creating incentives for the market but keep own public responsibilities • Criteria/conditions in tenders • Participation agreement • Vision development with developers (early collaboration) • Find parties for the middle term (30 years)/ operators • Stimulating/facilitating information sharing/ knowledge tables • Collect knowledge & make conditions for the area • Communication departments municipality
PROJECT DEVELOPER	• Incentive for circularity • Initiation CUAD • Taking responsibility/ direction • Creating trust • The need for change/CUAD • Including operators in project development • Include the parties that are relevant/ functional for the whole project cycle • Analysing area? Plan project with whole life cycle and parties involved • Creating a shared vision • Changing mindset quality before fast money • Find parties for the middle term (30 years)/ operators • Communication departments municipality
MAIN CONTRACTOR	• Scalable incentives CUAD • Increasing the number of recycled materials
ARCHITECT	
SUPPLIER	
SUBCONTRACTOR	• Selling the area

C2. PARK 20I20

C2.1 CUAD STRATEGIES APPLIED

Table C5- CUAD strategies of Park 20I20

	REGENERATE	SHARE	OPTIMISE	LOOP	VIRTUALISE	EXCHANGE
CONTEXT			Need for certifications			Paid land reservation
CONTENT	Water cool system	Efficient space usage PSS (Elevators)	(scientific) Research Research into C2C Design for function	Click bricks		C2C materials
PROCESS		Plan Go/no-go moments	Experiments Explorative workshops	Lessons learned Evaluation project	BIM	
ACTORS		Dialog users Frequent dialog project team		Continuous project team Evaluation collaboration		
POLICY DOCUMENTS						

Table C6- Description of the CUAD strategies of the Binckhorst

CUAD STRATEGY	DESCRIPTION
Watercool system	Rainwater is collected and used for cooling/other functions (toilet)
Efficient space usage	Shared facilitates of offices, for example, a shared auditorium or very large meeting room
PSS (Elevators)	Instead of buying the elevators, the elevator is rented. It is part of a take-back programme.
Plan Go/no-go moments	The development incorporates decision moments in which the feasibility of the development is evaluated
Dialogue users	The corporations who rent the buildings are consulted.
The frequent dialogue project team	Project team, so all different actors, have every two weeks an update meeting
Need for certifications	To ensure quality municipality wanted the highest BREEAM standards for the development of Park 20I20
Research into C2C	Throughput the development of Park 20I20 research continuously have been done on C2C materials
Design for function	The circular strategy should be based n the function of the building/area
Experiments	Knowledge is gained about C2C by experimenting and start constructing the first building
Explorative workshops	Insight and perspective of stakeholders have been included by workshops with client and users
Click bricks	Bricks that can be used multiple times
Lessons learned	After each building project lessons learned, have been documented into lessons earned
Evaluation project	Each project has been evaluated on the success
Continuous project team	Throughout the development of Park 20I20, the main project team has not changed much.
Evaluation collaboration	After each project, the collaboration between project team is evaluated
BIM	Building Information Modelling is applied
Paid land reservation	Develop can reserve the land for some time to come up with a development plan for the municipality
C2C materials	Uses of C2C certified materials

C2.2 LESSONS (TO BE) LEARNED

Table C7- Lesson learned from the development of Park20I20

	POSITIVE EXPERIENCE	NEGATIVE EXPERIENCE
ECONOMIC	Positive potential/ possible profits Kick-back Fee	Duration building projects Conditions practical implications/too many conditions Traditional financing sector
ENVIRONMENTAL	Vision/ point on the horizon Mixed-use area	
INSTITUTIONAL	Law enforcement CE/ legal regulations Risk analysis& communication Steering and control from abstracter level Flexibility in regulation Stimulant by example municipality	Legal conditions (building decisions) Lack of knowledge/ resources of the municipality Politics Disconnected municipality departments No blueprint
ORGANIZATIONAL	First investment common area** Driven project team Continuous project team	Knowledge is with the people/knowledge sharing
SOCIAL	Corporate social responsibility Include the client (workshops) Overarching/ guarding authority	The financial value of social benefits
SUPPLY CHAIN/ MARKET	First investment outside space** Enthusiasms/Innovators Include suppliers/ contractors in the beginning *CE certification* *Supply chain integration* Sharing knowledge (increase market demand) Linking knowledge	Lack of knowledge/ skills suppliers Learning new ways of working Lack of trust developers/ market
TECHNOLOGICAL	Collecting a lot of knowledge in the beginning Standardizations/CE bricks Scientific research Looking from other disciplines/perspectives	What's is sustainable? (long term/short term) Putting it in practice (theory vs practice)

C2.3 ROLES& RESPONSIBILITIES

Table C8- Roles and responsibilities of the involved actors of CUAD for Park 20I20

ROLES	RESPONSIBILITIES
MUNICIPALITY	• Zoning plan with the programme of requirements (abstract conditions) • Giving area character • *Sustainability condition (certifications*) • Decide on land ownership • Incentives building sustainable (kickback fee example) • *Decide focus points legal framework* • Steering through Qteam (keep/ get knowledge) • Overarching guiding/ active involvement • Linking knowledge/ public good CE knowledge • Linking techniques/ integration of market initiatives
PROJECT DEVELOPER(S)	• Initiation project • Analysing area& possibilities whole cycles project • General vision of project (CE vision) aim high • Setting boundary conditions • First initiation project team > getting the knowledge • Interact with clients (workshops) • Create an integrated vision • Risk analysis& communication • Include politics/ go &no- go moments • Creating trust
ENGINEER	• Include CE in deigns/ include whole cycles
MAIN CONTRACTOR	• Include CE whole project • Include operators and subcontractors in the early phase
ARCHITECT	• Include CE in design • Interact client (workshops)
SUPPLIER	• Technical knowledge/skills • Innovate/ Experiment
SUBCONTRACTOR	• Technical knowledge/skills • Innovate/ Experiment

C3. CROSS CASE ANALYSIS

C3.1 Lessons learned from the case studies

Table C9- Lessons learned cross-case analysis

THEME'S	BINCKHORST	PARK 20I20
PROFITABLE	The scale of demand to small Hub not profitable Uncertainty about risks Integrated business models/ performance	The financial value of social benefits Possible profit scenario's
POLICY/ LAW	Increasing contracts Increasing policy through EPA Flexibility in building plans Rules for quality Listen to council agreement	Risk analysis& public communication authorities Regulations enforcement CE Decide on land ownership
LACK OF KNOWLEDGE	Lack of knowledge activities area Lack of knowledge CUAD Lack of knowledge cost & benefits Division knowledge municipality	Lack of example/blueprint Collecting a lot of knowledge (in the beginning) Scientific research Lack of knowledge materials A new way of working Linking knowledge (looking from other disciplines/perspectives)
PRACTICAL IMPLEMENTATION	Successful examples Experimentation	Stimulant by example municipality Flexibility regulations

TRANSITION	Lack of trust market Reservation system cause double work EPA is to big a step Real estate sector	Incremental development (long duration building projects)
ACTORS	Participation agreement Find parties for 30 years(operators)	Include client Supply chain integration Include supplier/contractors/ architect in beginning
COLLABORATION	Information sharing Stimulate communication between departments municipality	Continuous project team Driven project team Sharing knowledge Disconnected municipality departments
VISION CUAD	CE responsibility market One developer/ overacting party Placemaking Selling the character of the area Vision development area Incentive CUAD through the developer	Dot on the horizon Overarching authority Giving area character Steering through Qteam Incentive CUAD trough municipality& developer Take whole cycles project into account
STIMULATING CUAD	Urgency society Urgency market CE responsibility market	Corporate social responsibility Integration of market incentives CE knowledge public good (linking)

C3.2 Conditions for circularity developed through the case study

Table C10- Conditions for circularity found through the case study research

CASE STUDY CONDITIONS	
	Lessons learned
POSSIBLE PROFITABLE SCENARIOS	Scale Risk management Integrated performance
INCLUDE POLITICS	Risk analysis& communication Emphasize council agreement
EXPERIMENTS	Stimulant example Learn by doing
INCREMENTAL TRANSITION	
STEERING THROUGH REGULATIONS	Regulated enforcement CUAD Flexibility in zonings plan
INCLUDE VARIETY OF STAKEHOLDERS	Participation agreement Include operators Include client Include supplier/contractor/architect
INFORMATION/KNOWLEDGE SHARING	Stimulate communication between parties (& between departments of the municipality) Continuous project team
VISION DEVELOPMENT	Selling the character of the area Point on horizon
STEERING PARTY/ INITIATOR CUAD	Incentive municipality/developer Overarching authority
CUAD ACTIVITIES/ACTORS OVERVIEW	
TECHNICAL KNOWLEDGE	Materials Techniques

D. THE FRAMEWORK DEVELOPMENT

D1. CONDITIONS FOR CIRCULARITY

Table D1- Literature study conditions versus case study conditions

CASE STUDY CONDITIONS		LITERATURE STUDY CONDITIONS	
Main condition	**Sub-conditions**	**Main condition**	**Sub-condition**
Possible profitable scenario's	*Scale* *Risk management* *Integrated performance*	Circular construction process	*An interactive and iterative process* *Sharing knowledge* *Changing roles& responsibilities*
Include Politics	*Risk analysis& communication* *Council agreement*	Multidisciplinary approach	*Variety stakeholders* *Variety of perspectives* *Network environment*
Experiments	*Stimulant example* *Learn by doing*	Guiding the process	*Overarching authority* *Rules& regulations*
Incremental transition	*Lack of trust in the market* *Behaviour real estate market*	ReSOLVE strategies	
Steering through regulations	*Regulated enforcement CUAD* *Flexibility in building plans*	Openness/transparency	
Include a variety of stakeholders	*Participation agreement* *Include operators* *Include client* *Include supplier/contractor/architect*	Iterative process	
Information/knowledge sharing	*Stimulate communication (between departments municipality)* *Continuous project team*	Speed in process	
Vision development	*Selling the character of the area* *Point on horizon*	Flexible process	
Steering party/ Initiator CUAD	*Incentive municipality/developer* *Overarching authority*	Inclusion of context	
Technical knowledge	*Materials* *Techniques*		

Table D2- Conditions for circularity

MAIN CONDITION	*Sub-condition*
1. INCLUDE POLITICS	
2. VISION DEVELOPMENT	*Dot on the horizon*
	Selling the character of the area
	Initiation phase
3. ADAPTABLE PROCESS	*Flexible*
	Experimental
	Iterative and interactive
4. PROFITABLE BUSINESS SCENARIOS	*Scale*
	Risk management
5. INCREMENTAL TRANSITION	
6. INFORMATION SHARING/ TRANSPARENCY	*Transparency/ openness*
	Continuous project team
	Communication (between departments)
7. CUAD (ACTIVITIES/ ACTORS) OVERVIEW	
8. INCLUSION OF CONTEXT ASPECTS	
9. NEED FOR STEERING	*Inclusion of context aspects*
	Need for steering
10. CHANGING ROLES AND RESPONSIBILITIES	
11. RESOLVE STRATEGIES	
12. TECHNICAL KNOWLEDGE	*Materials*
	Techniques
13. VARIETY OF INVOLVED STAKEHOLDERS	*Variety of perspectives*
	Network environment
	Early involvement

Table D3- Definitions of the conditions for circularity

MAIN CONDITION	DEFINITION
1. INCLUDE POLITICS	Include politics in the decision making for the project of CUAD. Through incorporating go/no-go moments and by communicating risk with public authorities (risk management).
2. VISION DEVELOPMENT	CUAD is in need of a general vision. Not a determined worked-out plan but a point on the horizon. CUAD should, therefore, following one or more strategy from the ReSOLVE framework as a guideline for the are development.
3. ADAPTABLE PROCESS	Important for CUAD is to able to adapt to a dynamic and uncertain environment. Furthermore, CUAD should be a learning process through experiments, interactive feedback and evaluations of the work.
4. PROFITABLE BUSINESS SCENARIOS	Transition to CUAD will not occur if the trough the transition no profits are made. Incorporating risks and analysing profitable business scenarios I therefore important.
5. INCREMENTAL TRANSITION	Various uncertainties exist about CUAD. Materials, product, process, roles and responsibilities have to change. Changes which cannot occur suddenly. Through incremental transitions, risks are decreased, and trust can more easily be gained.
6. INFORMATION SHARING/ TRANSPARENCY	CUAD is in need of a multidisciplinary approach and in need of collaboration. The transition to CUAD cannot occur individually. Sharing information, knowledge and resources is therefore important.
7. CUAD (ACTIVITIES/ ACTORS) OVERVIEW	For CUAD, it is important to know which parties are involved (during the whole project life cycle). Because phases, activities and parties of the development process are linked in CUAD.
8. INCLUSION OF CONTEXT ASPECTS	CUAD should suit the context. Development should strive for including Resolve strategies that fit context variables like financial and legal conditions.
9. GUIDING THE PROCESS	To ensure CUD, to ensure that the process is focused on the point on the horizon, a steering authority is needed. Transition to CUAD can occur of imitator emphasizes and guides the transition.
10. CHANGING ROLES AND RESPONSIBILITIES	Traditional roles of UAD have to change. Trust has to be developed through municipality and market. Stakeholders of CUAD should collaborate. Stakeholders of CUAD cannot solely be focused on their "own" task or role. CUAD is in need of integration of roles and responsibilities.
11. RESOLVE STRATEGIES	CUAD should follow the ReSOLVE strategies. Each development should apply the strategy(ies) with the highest circular impact that suits the particular development context
12. TECHNICAL KNOWLEDGE	Management of CUAD cannot wholly be separated from technical aspects. Furthermore, lack of technical

	knowledge is an important barrier for the transition. Therefore technical knowledge about materials and techniques is necessary for the transition to CUAD.
13. VARIETY OF INVOLVED STAKEHOLDERS	CUAD is concerned with a network of actors. Furthermore, a variety of perspective and disciplines is necessary for a successful transition. It is important to consider these perspectives in an early stage.

E. PILOT STUDY

E1. PARTICIPANTS

Table E1- The participants of the CUAD pilot

ROLLEN	COMPANY	NAME	TASKS
CLIENT	Rotterdam Makers District		Vison zonings plan for Galilei Park
"ARCHITECT"	PoR Authority (Delva)		Perspective from Delva Architects
PRODUCT OWNER	PoR Authority		Translate the objective and requirements Rotterdam Makers District
SCRUM MASTER	TU Delft/ PoR Authority		Value the CUAD process
CONSULTANT	PoR Authority		Circular principals of M4H

E2. FEASIBILITY CRITERIA QUESTIONNAIRE

Table E2- Questions for the feasibility study of the CUAD pilot

CRITERIA	QUESTION
Knowledge scrum	What does your personal scrum role entail? Which events/sessions were held during the pilot?
Relevance	How relevant do you find scrum for this kind of development/ design questions? On a scale from 1 to 10?
Impression scrum	What is your general impression of the scrum way of working? (on a scale from 1 to 10)
Impression pilot	What is your general impression of the pilot? (on a scale from 1 to 10)
Follow up scrum	Do you think a follow up should be initiated for the scrum way of working?
Follow up	Do you think a follow-up for the outcome of the pilot should be initiated?

E3. RESULTS PILOT STUDY

E3.1 CUAD CONDITIONS IN THE PILOT

Table E3- Conditions for circularity applied in the CUAD pilot

CONDITIONS FOR CUAD	CUAD PILOT DESIGN CONDITIONS	RESULT IMPLEMENTATION OF CONDITIONS IN CUAD PILOT	
ADAPTABLE PROCESS	Multiple sprints	+	Two sprints
INCREMENTAL TRANSITION	One week iterations	+	Focus on a single principle
NEED FOR STEERING	CUAD focus (scrum master & product owner)	+	CUAD focus (scrum master)
INCLUDE POLITICS	"Based on (agreed upon) Ruimtelijk Raamwerk"	+/-	Based on (agreed upon) Ruimtelijk Raamwerk"
TRANSPARENCY	Decisions/session shared with parties outside of the project team	-	-
VARIETY OF INVOLVED STAKEHOLDERS	Including actors outside of the scope of developing Galilei Park	+/-	Include project engineer of another project
CHANGING ROLES AND RESPONSIBILITY.	Designate scrum roles and responsibilities	+	Designate scrum roles and responsibilities
CUAD (ACTORS/ ACTIVITIES) OVERVIEW	Analysing what type of knowledge is necessary for objectives and tasks	+	Analysing all interest actors temporary storage
VISION DEVELOPMENT	Kick-off indicates vision through CUAD strategies	+	Kick-off indicates vision through circular principles
PROFITABLE BUSINESS SCENARIOS	Prioritisation of objectives and tasks	+	Prioritisation based on Impact and Effort. The effort is defined as time and resources.
TECHNICAL KNOWLEDGE	Include consultants and engineers during the kick-off to increase knowledge	+	Include consultants and engineers during the kick-off to increase knowledge
RESOLVE STRATEGIES	Selecting only circular principles that are in line with CUAD ReSOLVE strategies.	+	Selection of circular principles that are concerned with construction streams.

INCLUSION OF CONTEXT	Legal and economic boundaries will be analysed.	+/-	Variables that have been considered are the duration of the pilot, schedule of the project team, and legal boundaries

E3.2 FEASIBILITY CRITERIA

Table E4- The feasibility criteria

FEASIBILITY CRITERIA	MEASURING UNITS	Outcome pilot study	Results pilot study*
CONCEPT	Is an actor overview at the start of the project made? Yes/No	YES	+
OUTCOME	- Range of 10r framework Should be between 0-4 r - Does as follow-up exist: Yes/Np	- Re-use (3R) - YES	+
PROCESS	Feedback moments should be incorporated into the process. At least two.	Two feedback moments	+
ACTORS	The (whole) project team should contain at least three team members with different expertise.	Engineer Environmental consultant Architect	+/-
KNOWLEDGE SCRUM	Participants answer more than half of the evaluation questions relate to the scrum event, roles and artefacts right.	YES	+
FEEDBACK SCRUM	The overall pilot has been evaluated more than satisfactory (has an average grade of 7 or higher (on a scale from 1 to 10). The scrum way of working has been evaluated more than satisfactory(has an average grade of 7 or higher (on a scale from 1 to 10).	- 7,4 - 7,4	+
FOLLOW UP	Yes/No	YES	+

E3.3 OUTCOME OF THE PILOT EVENTS

Table E5- Activities and outcome Kick-off

STEP	ACTION	OUTCOME
INTRODUCTION	-	Focus on incorporating CUAD through CE principles in zonings plan of Galilei Park in M4H
VISION OF THE PROJECT	ReSOLVE strategies Ranking game	Value waste streams of M4H
PRODUCT BACKLOG OBJECTIVES	1.Brainstorming	- Give the tasks to value streams to designers/architects - Overview planned projects in Galilei Park - Consult current CUAD/CE initiatives how they should value waste streams - Analyse future streams (for material passport) - Examine how valuing streams can be guarantee through tenders/contracts - Examine what kind of materials current building/infrastructure contains to develop "storage construction materials." - BIM application and material passport - inventory of supply and demand - help desk for parties located in M4H and also for parties outside
	2. Prioritise - Impact vs Effort - 10r framework	1. Application of sustainable materials: the Lekstraat as case 2. Temporary storage for used materials 3. Communication canals
SPRINT BACKLOG	Selection based on time/duration	Temporary storage place for waste materials and communication canals

Table E6- Activities and outcome of Sprint planning 1

STEP	ACTION	OUTCOME
INTRODUCTION	Recap kick-off Sprint planning & team	Extensive long list (not that practical Roles reminder + goal pilot
DETERMINE & PRIORITIZE	ReSOLVE strategies Effort/ Impact	- Prioritize through time(1 to 5); tasks can be combined/are similar - Five tasks where (1) analysis of interested and involved actors (intern, extern+ values, businesses), (2) programme of requirements (PVE), (3)locations, (4)map out material streams of M4H (law regulations, current project and over 2 years) & (5) management system is needed.
	Duration Categorization	- More task longer than week - One can be completed during the sprint planning
DECIDE TASKS		- Isabelle, Marielle and Pim have allocated tasks to themselves
DECIDE TASKS FOR THE HOUR		PVE - Mobiliteit: voor truck/vrachtauto's, bestaande infrastructuur(#?) - Bodem: Bodem sanering (scan), draagvermogen - Inrichting: Verhard, niet vloeistof dicht, omhekt, aansluiting (riolering, elektra, verlichting), beveiliging (camera), brandveiligheid - Labeling materialen
WRAP UP	-	

Table E7- Activities and 0utcome of Sprint planning 2

STEP	ACTION	OUTCOME
INTRODUCTION	Recap sprint 1 Lessons learned	Three lessons learned - Good= method is concrete - Can be better= more structure (vision) - Added= role specification
DETERMINE & PRIORITIZE	Goal pilot & tasks done Effort/ Impact	- Task completed: overview actors, law regulations materials, intern resources, locations & PVE - Recap task temporary storage now 8 actions - 8 actions are: analysis of interested and involved actors, the programme of requirements (PVE), scale, locations, map out material streams of M4H, a management system is needed, duration and planning & cultural behaviour
PLANNING	Duration Categorization	- Task during planning; scale & (global) planning/duration - The conclusion was drawn that for implementation in masterplan all actions have been completed - Remaining tasks are the realisation (1. Business case (feasibility study), four project material, from actors & over two years, cultural& behaviour)
DECIDE TASKS		
WRAP UP	What's next?	- Possibility of the project plan? - Evaluation with stakeholder - Documentation & communication of findings