Adopting circular innovative technologies in the construction supply chain of the MRA

Supply Chain through the lenses of the service

dominant logic's foundational premises

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Bouwend Nederland

de vereniging van bouw- en infrabedrijven

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MSc Thesis

by

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The master's thesis is written for those who are involved in or are interested in the realization of circular innovative technologies within organizations in the Dutch Construction sector.

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SUMMARY

1. INTRODUCTION

In the 21st century, increased population growth, industrialization and demand for goods and services has resulted in tremendous demand for global resources. This has resulted in scarcity of key resources and production of waste. The construction sector is one of the biggest consumers of raw materials and generates large amounts of construction waste as well. Most constructions today are based on linear take-make-waste models where non-renewable resources are extracted, processed and used, whereas circular economy (CE) is characterized by new business models, innovative avenues of employment, improved well-being, sustainable use of resources and a balanced society. CE is a way to delink the construction sector from the consumption of finite resources of the earth and excessive waste generation.

While most research on CE has been performed with respect to social and organisational innovations such as circular business models, production and consumption models, there is not much clarity on how CE can be leveraged in the construction sector. Despite of the fact that there are a lot of interventions, such as Commodity agreement, Transition Agenda, it is not clear how CE can be executed in practice and what the supply chain parties are experiencing and what their expectation are, because at the end these are the parties who are going to circular innovations to contribute to CE. However in practice an enormous discrepancy exists between parties offering circular innovative technologies (CIT) on the one side, and actual execution of these CITs on the other side. CITs for the construction sector includes reinterpreting how materials, processes and products in the construction sector get designed and used, how resources such as raw materials, get managed, how waste generation can be reduced or eliminated and methods of recycling and reusing materials. Therefore, this research aims to develop a guidance and a framework on the adoption of more circular innovative technologies in construction projects and to propose an approach that can support involved parties in order to realize more circular construction projects. The main question of this research is as followed:

What do the supply chain parties in the construction industry need in order to adopt Circular innovative technologies to realize their circular ambitions?

This research takes the view that transitioning the construction sector from its current linear style to a CE characterized by closed loop will not happen without considerable changes in modes of operation. All the stakeholders involved – including government authorities, contractors, clients, architects, engineers, and

suppliers must act to make the circular economy a reality. Integration between these stakeholders will be key to achieve the objectives of CE in the construction sector.

This research adopts a unique approach in transitioning the construction sector to a CE using Service Dominant Logic (SDL). According to SDL the exchange of services is accompanied by the simultaneous exchange and deployment of various skills and competencies of all stakeholders involved in a transaction. This theory is based on eleven foundational premises according to which it is not exchange of goods that characterize most commercial transactions today as much as that of ideas, knowledge and expertise. SDL becomes a tool that promotes various kinds of tangible and intangible innovation. These new products can then be leveraged to provide different services. This research will explore how SDL theory can be used to propose those unique services that can enable the construction sector to transition to a CE.

2. THEORY

This research proceeds from the premise that transitioning the construction sector to a CE involves developing innovative methods of thinking and working together. Currently it is the lack of adoption of circular innovative technologies (CIT) that is preventing the construction sector from adopting CE. SDL theory offers a possible solution to this problem. SDL is about the process of creating activities and the process of delivering activities (Brodie et al., 2006). This process starts with the "Parties with resources" or those agents who have developed circular innovations in the form of new materials, techniques (CIT) or working methods (social innovation) (Michel et.al., 2008). These are the resources that can potentially promote CE in the construction sector. These agents get involved in the supply chain in two ways. Firstly, they help to create value and secondly, they enter into dialogue or interact with a requesting party or client, also called "Beneficiary". The demand arises from ambitions the beneficiary has regarding the circular economy which is to develop services termed “Value Propositions". Value proposition is developed in conjunction with the agents who have innovative solutions (Cesaroni, 2013, & Melancon et al., 2010). Observed that the value proposition is also developed through interactions with other parties or stakeholders who are involved in the construction project. If these value propositions have been made, then it is clear which circular innovation can deliver a certain value or service.

There are 11 foundational premises (FP’s) that underlie SDL theory and which were extended in this research to the construction sector. For example, as it can be seen in table 1 FP2 refers to indirect exchanges was reinterpreted as circular innovation being subordinate to other interests in the construction sector. FP6 refers to value co-created by multiple actors which was used to identify identity all those involved parties that are

necessary to implement CE. FP9 states that all social and economic actors are resource integrators which in the construction sector refers to the willingness to share knowledge and resources. FP11 refers to value co-creation processes which in the construction context refers to the co-operation required from multiple stakeholders for the effective implementation of CE. These factors were used to formulate a theoretical model that was then applied to the construction sector.

SDL's Foundational Premises	Themes for CE
FP1. Service is the fundamental basis of exchange	Opportunities for cooperation
FP2. Indirect exchange masks the fundamental basis of exchange	Circular ambition/innovation subordinate to other interests
FP3. Goods are distribution mechanisms for service provision	How circular ambition/technology looks like and works
FP4.Operant resources are the fundamental source of strategic benefit.	Indispensability of circular technology/ambition in the supply chain
FP5. All economies are service economies	Experienced problems within CE
FP6. Value is co-created by multiple actors, always including the beneficiary	Indispensable parties
FP7. Actors cannot deliver value but can participate in the creation and offering of value propositions	Circular procurement
FP8. A service-centered view is inherently beneficiary oriented and relational	The reason for cooperation
FP9. All social and economic actors are resource integrators	Needed resources
FP10. Value is always uniquely and phenomenologically determined by the beneficiary	Directing role
FP11. Value co-creation is coordinated through actor-generated institutions and institutional arrangements	Optimal cooperation

Figure 1: Interpretation of SDL's foundational premises to construction industry (own ill.)

3. METHOD

A qualitative method was devised for this research consisting of both primary and secondary data collection activities. The secondary data was collected through desk research and helped identify the 11 themes of SDL theory. The secondary data analysis was also used to formulate the theoretical model. The interview was developed according to the 11 themes of SDL theory. To investigate these eleven themes there is chosen for the metropolitan region of Amsterdam (MRA). MRA wants be internationally a pioneer, puts a clear focus on circular economy in this region, have their circular building program and also have a good overview of what they want. The companies in which the interviews were held were divided into (a) demand, (b) supply and (c) demand and supply firms. This division of parties is made from point of view of SDL theory, where beneficiary, parties that have circular ambitions (demand) and parties with resources who are offering a certain circular innovative technologies (supply) should interact to realize more circular projects. Since there are also parties who can take both functions, there are also demanders & suppliers. The interaction between these stakeholders is expressed through snowball sampling technique where the parties traced by asking for the contact information from other members of the targeted group. An overview of these targeted groups in MRA is provided by TNO (2016). These group of parties include clients, consultancies, architects and engineers, real estate developers, construction companies, suppliers of building materials, wholesaler of building materials and recycling companies who are operating in the construction sector in the metropolitan area of Amsterdam.

The primary data collection instrument was an interview which was administered to the respondents in a semi-structured interview. The thematic analytic method was used to analyse primary data collected from the various respondents. Thematic analysis is the most common form of analysing primary data in qualitative studies (Bazeley, 2009). The underlying principle of thematic analysis is to identify recurring themes emerging from the data, coding these themes and then interpreting them with regard to secondary data. This interpretation led to developing recommendations on what needs to be done by each of the 3 stakeholders to facilitate the transition of a linear construction industry to a circular one.

4. FINDINGS & DISCUSSION

The analysis indicated several benefits for the 3 stakeholders. These include contributing to resource conservation, elimination of Waste, contributing to environmental sustainability, less dependence on external raw material sources, ready made source of input materials, employment generation,

and tax incentives. Several obstacles towards the adoption of a CE were also identified. These includes the unfamiliarity of the CE concept, lack of knowledge about CE, high initial costs of implementing CE, lack of adequate CE infrastructure, higher risk perception, governmental pressure, lack of regulations and standards as well as a lack of monitoring.

The analysis of the supply chain across the 11 FPs of SDL also revealed many findings pertaining to CE, which can be seen in figure 2. For example, FP1 it was found that the generation of new ideas that will promote CE adoption is contingent on securing cooperation from multiple stakeholders in the construction sector. For FP2 it was found that incorporating CE will depend on how much priority is given to it by stakeholders. CE projects are hampered by pressures of time and cost overruns and by reluctance of clients to pay higher prices for CE construction. According to the findings for FP4, it is important for any CE initiative or technology to be commercially viable and value adding. If there is no added value from CE initiatives, it will not be adopted in the construction sector.

Themes	Findings
FP1. Opportunities for cooperation	Generation of new ideas
FP2. Circular ambition/innovation subordinate to other interests	Pressures of time and cost overruns Reluctance of clients to pay high prices
FP3. How circular ambition/technology looks like and works	Based on functionality and performance
FP4. Indispensability of circular technology/ambition in the supply chain	Commercially viable and value adding
FP5. Experienced problems within CE	No quantitative metrics or measuring instruments to measure CE effectiveness No legal framework for CE implementation Lack of awareness about CE No clear differences between CE and sustainability
FP6. Indispensable parties	Different parties for each party
FP7. Circular procurement	Easily demountable Based on % secondary materials MKI Functional tendering DBFM or Building Team Not based on price
FP8. The reason for cooperation	Cost savings Added value Enhanced customer satisfaction Environmental conservation New job opportunities
FP9. Needed resources	Government policies Knowledge from other parties
FP10. Directing role	Different parties for each party
FP11. Optimal cooperation	Openness and transparency amongst all the stakeholders Profit sharing Willingness to take risks

Figure 2: Findings from the interviews (own ill.)

Opportunities

it is observed that all the demanders have indicated that a transition to a CE will lead to less dependence of the construction sector on new raw material procurements. Also the demanders have indicated, this will lead to fewer emissions for operating the building and help them make a contribution to preservation of the environment. It is noticed that all the suppliers feel that adopting CE principles will enhance the brand value to become a frontrunner. Suppliers will be able to avail of tax incentives given by the Dutch Government to parties who promote sustainable construction practices thereby lowering input costs. The suppliers also indicate that CE will provide them access to ready-made input sources which will have the impact of driving down input costs. It is noticed that as the construction sector as a demander & supplier will benefit from lesser consumption of raw materials and natural resources through CE.

Challenges

The administrative pressure is the main reason for non – adoption of CE by the demanders. Geraedts et al., (2015) observed that construction firms are under pressure from clients who want the projects completed as quickly as possible and from government authorities who push from faster constructions in order to counter the growing demand for housing and commercial space. In such a scenario, it becomes difficult to devote time and resources incorporating CE principles into construction plans.

It is observed that all the suppliers feel that CE is a new concept and still not very well developed. This prevents them from using CE more in their projects. All the suppliers indicate that there is a lack of co-operation and co-ordination amongst the various stakeholders in construction projects that make it difficult to adopt CE in a cohesive manner in any project.

It can be noticed that demander and supplier firms face pressure from both the clients and the government for the quick completion of their construction projects. This makes it difficult to incorporate CE principles in construction projects. Another recurring theme is the lack of awareness and the unfamiliarity associated with CE adoption in the construction sector.

From the findings of the primary data analysis it was concluded that the main activities that will accelerate circular construction projects include (a) clear definition of circular economy with quantitative circular indicators (b) circular procurement (c) making more secondary materials available and (d) directing role. In addition, for transitioning to a completely circular economy it is necessary for co-operation and co-ordination amongst all the supply chain operating in the construction sector.

5. CONCLUSION

Circular economy is only at the very beginning of transition. To be completely circular, there is all the parties from the supply chain needed. However, there are parties who can try

to make a transition within their own organization, within what is now possible in the field of circular economy and become distinctive. The biggest necessity for the transition to the circular economy is to tackle it in practice, by both the supplier and demanders. Creating demand, which will result in competition and the currently (too) expensive materials will become more profitable for more and more supply chain parties through creating a mass.

Circular economy needs long-term thinking which makes the requirements for materials uncertain. As long as virgin materials are cheaper than secondary materials the preference will be for virgin materials. This can be counteracted by levying taxes on primary materials or making subsidy available on secondary materials. However it is only possible when there is enough secondary materials are available. One of the key sources of non – adoption of CE is the lack of harmony or agreement on a suitable definition of CE for the construction sector. This may compromise the process of decision-making and eventually lead to ineffective policy interventions. Successfully implementing CE in the construction sector needs a definition that covers the whole construction supply chain to provide understanding of material flows in the economy. This will create a "Common Reference Framework" assess progress against and meet set objectives as well as identify source of inefficient use of resources and opportunities for resource efficiency.

6. RECOMMENDATION

Several recommendations may be made to the various stakeholders in the construction sector for transitioning to a full CE. For example, demanders are recommended to commit to the circular economy, use CE based procurement processes, encourage innovation & collaboration. Demanders and suppliers are recommended to advise clients, incorporate CE principles in building design, involve manufacturers of construction products etc. Recommendations for suppliers include developing end of life options for construction products, develop return schemes offer product as service etc. However in order to do these there must be more clarity about the definition of circular economy. The question is whether there will be an uniform definition, but there must be some direction, guideline for a definition of circular economy. Also creating awareness of supply chain parties is important to realize the benefits of CE in order to apply it in practice. Once they realize the benefits of CE and how they can generate profits from it, CE will speed up.

SAMENVATTING

1. INTRODUCTIE

In de 21ste eeuw resulteerde een toegenomen bevolkingsgroei, industrialisatie en de vraag naar goederen en diensten in een enorme vraag naar wereldwijde hulpbronnen. Dit heeft geresulteerd in schaarste aan essentiële hulpbronnen en productie van afval. De bouwsector is een van de grootste verbruikers van grondstoffen en genereert ook aanzienlijke hoeveelheden bouwafval. De meeste constructies van vandaag zijn gebaseerd op lineaire take-make-waste-modellen waarbij niet-hernieuwbare hulpbronnen worden gewonnen, verwerkt en gebruikt, terwijl Circulaire Economie (CE) wordt gekenmerkt door nieuwe bedrijfsmodellen, innovatieve banen, verbeterd welzijn, duurzaam gebruik van grondstoffen en een evenwichtige samenleving. CE is een manier om de bouwsector te ontkoppelen van de consumptie van schaarse grondstoffen van de aarde en overmatige afvalproductie.

Hoewel het meeste onderzoek naar CE is uitgevoerd met betrekking tot sociale en organisatorische innovaties zoals circulaire bedrijfsmodellen, productie- en consumptiemodellen, is er niet veel duidelijkheid over hoe CE kan toegepast worden in de bouwsector. Ondanks vele ontwikkelingen, zoals Grondstoffenakkoord en Transitiegenda, is het niet duidelijk hoe CE in de praktijk kan worden uitgevoerd, hoe de ketenpartijen CE ervaren en wat hun verwachtingen zijn, want uiteindelijk zijn dit de partijen die circulaire innovaties gaan toepassen om bij te dragen aan CE.
In de praktijk bestaat er echter een enorme discrepantie tussen partijen die enerzijds circulaire innovatieve technologieën (CIT) aanbieden en anderzijds de daadwerkelijke uitvoering van deze CIT's. CIT-en voor de bouwsector omvatten een herinterpretatie van hoe materialen, processen en producten in de bouwsector worden ontworpen en gebruikt, hoe hulpbronnen zoals primaire grondstoffen worden beheerd, hoe afvalproductie kan worden verminderd of geëlimineerd en methoden voor recycling en hergebruik van materialen. Dit onderzoek richt zich daarom op het ontwikkelen van een leidraad en een kader voor de implementatie van meer circulaire innovatieve technologieën in bouwprojecten. Tevens wordt een aanpak voorgesteld die betrokken partijen kan ondersteunen om meer circulaire bouwprojecten te realiseren. De hoofdvraag van dit onderzoek is als volgt:

Wat hebben de ketenpartijen in de bouw nodig om circulair innovatieve technologieën toe te passen om hun circulaire ambities te kunnen realiseren?

De overgang van de bouwsector van zijn huidige lineaire stijl naar een CE die

wordt gekenmerkt door een gesloten kringloop zal niet plaatsvinden zonder aanzienlijke veranderingen in de manier van functioneren. Alle betrokken stakeholders - inclusief overheidsinstanties, aannemers, klanten, ontwerpers, architecten, ingenieurs en leveranciers - moeten meewerken om de circulaire economie te realiseren. Integratie tussen deze stakeholders is cruciaal om de doelstellingen van CE in de bouwsector te bereiken.

Dit onderzoek past een unieke benadering toe bij de overgang van de bouwsector naar een CE met behulp van Service Dominant Logic (SDL). Volgens SDL gaat de uitwisseling van diensten gepaard met de gelijktijdige uitwisseling en inzet van verschillende vaardigheden en competenties van alle betrokken stakeholders. Deze methode is gebaseerd op 11 fundamentele uitgangspunten. Deze uitgangspunten laten zien dat de uitwisseling van ideeën, kennis en expertise de meeste handelstransacties kenmerken, en niet de uitwisseling van goederen. SDL bevordert verschillende soorten tastbare en ontastbare innovaties. Deze nieuwe producten kunnen vervolgens worden gebruikt om verschillende diensten aan te bieden. Dit onderzoek zal verkennen hoe de SDL-theorie kan worden gebruikt om die unieke diensten te introduceren die de bouwsector in staat kan stellen om over te stappen naar CE.

1. THEORIE

Dit onderzoek gaat uit van het uitgangspunt dat de overgang van de bouwsector naar een CE gepaard gaat met het ontwikkelen van innovatieve denk- en samenwerkingsmethoden. Momenteel wordt de adoptie van CE in de bouwsector verhinderd door het gebrek aan het toepassen van circulair innovatieve technologieën (CIT). De SDL-theorie biedt een mogelijke oplossing voor dit probleem. SDL omvat het proces van het creëren van activiteiten en het leveren van activiteiten (Brodie et al., 2006). Dit proces begint met de "Partijen met middelen" of partijen die circulaire innovaties hebben ontwikkeld in de vorm van nieuwe materialen, technieken (CIT) of werkmethoden (sociale innovatie) (Michel et.al., 2008). Deze middelen kunnen de CE in de bouwsector bevorderen. De genoemde partijen raken op twee manieren betrokken bij de keten. Ten eerste dragen ze bij aan het creëren van meerwaarde en ten tweede gaan ze een dialoog aan of communiceren ze met een vragende partij of cliënt, ook wel "Beneficiary" genoemd. De vraag komt voort uit de ambities die de begunstigde heeft ten aanzien van de circulaire economie, om diensten te ontwikkelen die "Value Propositions" worden genoemd. Waardepropositie wordt ontwikkeld in samenwerking met de partijen met innovatieve oplossingen (Cesaroni 2013., & Melancon et al., 2010). Het is waargenomen dat de waardepropositie ook wordt ontwikkeld door interacties met andere partijen of stakeholders die bij het bouwproject betrokken zijn. Als

deze waardeproposities zijn gemaakt, wordt het duidelijk welke circulaire innovatie een bepaalde waarde of dienst kan leveren.

In dit onderzoek zijn de 11 fundamentele uitgangspunten (FP's) die ten grondslag liggen aan de SDL-theorie toegepast in de bouwsector. Een aantal van de uitgangspunten wordt hierna toegelicht aan de hand van figuur 1. Bijvoorbeeld FP2 refereert naar indirecte uitwisselingen die werden geïnterpreteerd als circulaire innovatie die ondergeschikt kan zijn aan andere belangen in de bouwsector. FP6 verwijst naar de waarde die door meerdere actoren is gerealiseerd en die wordt gebruikt om alle betrokken partijen te identificeren die nodig zijn om CE te implementeren. FP9 stelt dat alle sociale en economische actoren "resource integrators" zijn. Deze verwijzen in de bouwsector naar de bereidheidwilligheid om kennis en middelen te delen. FP11 verwijst naar waarde co-creatie processen die in de constructiecontext verwijst naar de samenwerking die vereist is van meerdere stakeholders voor de effectieve implementatie van CE. Deze factoren werden gebruikt om een theoretisch model te formuleren dat vervolgens werd toegepast op de bouwsector.

Fundamentele uitgangspunten van SDL	Thema's voor CE
FP1. Service is de fundamentele basis van uitwisseling	Kansen voor samenwerking
FP2. Indirecte uitwisseling verdoezelt de fundamentele basis van uitwisseling	Circulaire ambitie / innovatie ondergeschikt aan andere belangen
FP3. Goederen zijn verdelingsmechanismen voor dienstverlening	Hoe circulaire ambitie / technologie eruit ziet en werkt
FP4. Operante middelen (zoals vaardigheden en kennis) zijn de fundamentele bron van strategisch voordeel	Onmisbaarheid van circulaire technologie / ambitie in de keten
FP5. Alle economieën zijn dienst economieën	Ervaren problemen binnen CE
FP6. Waarde wordt co-gecreëerd door meerdere actoren, waar de begunstigde altijd is bij betrokken	Onmisbare partijen
FP7. Actoren kunnen geen waarde leveren maar kunnen deelnemen aan het creëren en aanbieden van waardeproposities	Circulaire inkoop
FP8. Een service gecentreerd standpunt is inherent begunstigde georiënteerd en relationeel	Aanleiding voor samenwerking
FP9. Alle sociale en economische actoren zijn de partijen die gun middelen bij elkaar brengen	Nodige middelen
FP10. De waarde is altijd uniek en fenomenologisch bepaald door de begunstigde	Regierol
FP11. Waarde co-creatie wordt gecoördineerd door actor gegenereerde instellingen en institutionele afspraken	Optimale samenwerking

Figuur 1: Interpretatie van de fundamentele uitgangspunten van SDL naar de bouw industrie (eigen ill.)

3.METHODE

Voor dit onderzoek is een kwalitatieve methode ontwikkeld die bestaat uit zowel primaire als secundaire gegevensverzameling. De secundaire gegevens werden verzameld via desk research en hielpen de 11 thema's van de SDL-theorie te identificeren. De secundaire data-analyse werd ook gebruikt om het theoretische model te formuleren. Het interview is ontwikkeld volgens de 11 thema's van de SDL-theorie. Om deze 11 thema's te onderzoeken, is er gekozen voor de metropoolregio Amsterdam (MRA). MRA wil internationaal een pionier zijn, legt een duidelijke focus op CE in de regio, heeft een circulair bouwprogramma en een goed overzicht van wat zij willen.De bedrijven waarmee de interviews werden gehouden, zijn onderverdeeld in (a) vragende partijen, (b) leverende partijen en (c) vragende en leverende partijen. Deze onderverdeling is gemaakt vanuit de SDL theorie, waarbij "Beneficiary", partijen met circulaire ambities (vraag) en partijen met middelen die een bepaalde CIT (aanbod) aanbieden moeten samenwerken om meer circulaire projecten te realiseren. Aangezien er er ook partijen zijn die beide functies kunnen vervullen, is er ook de onderverdeling: vragende en leverende partijen.

De interactie tussen deze stakeholders komt tot uiting in een sneeuwbal steekproeftechniek waarbij de partijen getraceerd werden door de contactinformatie van andere leden van de doelgroep te vragen. Een overzicht van deze doelgroepen in MRA wordt verstrekt door TNO (2016). Deze groep partijen omvat klanten, adviesbureaus, architecten en ingenieurs, vastgoedontwikkelaars, bouwbedrijven, leveranciers van bouwmaterialen, groothandel in bouwmaterialen en recyclingbedrijven die actief zijn in de bouwsector in het grootstedelijk gebied van Amsterdam.

Het primaire instrument voor gegevensverzameling was een interview dat in een semigestructureerde wijze aan de respondenten werd toegediend. De thematische analyse methode werd gebruikt om primaire gegevens te analyseren die werden verzameld door de verschillende respondenten. Thematische analyse is de meest gebruikelijke vorm van analyse van primaire gegevens in kwalitatieve studies (Bazeley, 2009). Het onderliggende principe van thematische analyse is het identificeren van terugkerende thema's die uit de gegevens naar voren komen, deze thema's coderen en ze vervolgens interpreteren met betrekking tot secundaire gegevens. Deze interpretatie leidde tot het ontwikkelen van aanbevelingen over wat er door elk van de 3 stakeholders moet gebeuren om de overgang van een lineaire constructie-industrie naar een circulaire te vergemakkelijken.

4. BEVINDINGEN & DISCUSSIE

De analyse gaf verschillende voordelen voor de 3 stakeholders. Deze omvatten bijdragen aan de instandhouding van hulpbronnen, eliminatie van afval,

bijdragen aan ecologische duurzaamheid, minder afhankelijkheid van externe grondstofbronnen, kant-en-klare bron van inputmaterialen, het genereren van werkgelegenheid en fiscale prikkels. Verschillende obstakels voor het toepassen van CE werden ook geïdentificeerd. Deze omvatten de onbekendheid van het CE-concept, gebrek aan kennis over CE, hoge initiële kosten van de implementatie van CE, gebrek aan adequate CE-infrastructuur, hogere risicoperceptie, administratieve druk, gebrek aan wet- en regelgeving, evenals een gebrek aan monitoring.

De analyse van de keten in de 11 FP's van SDL onthulde ook veel bevindingen met betrekking tot CE, zoals te zien figuur 2. Voor FP1 werd vastgesteld dat het genereren van nieuwe ideeën die het toepassen van CE zullen bevorderen, afhankelijk is van het veiligstellen van de samenwerking van meerdere belanghebbenden in de bouwsector. Voor FP2 werd vastgesteld dat het toepassen van CE afhankelijk zal zijn van de prioriteit die belanghebbenden eraan geven. CE-projecten worden belemmerd door tijddruk, kostenoverschrijdingen en door terughoudendheid van klanten om hogere prijzen te betalen voor CE-constructie. Volgens de bevindingen voor FP4 is het belangrijk dat elk CE-initiatief of elke technologie commercieel haalbaar is en meerwaarde heeft. Als CE-initiatieven geen meerwaarde hebben, zal het niet worden overgenomen in de bouwsector.

<u>Kansen</u>

Alle vragende partijen hebben aangegeven dat een overgang naar een CE zal leiden tot minder afhankelijkheid van de bouwsector voor nieuwe inkoop van grondstoffen. Ook de vragende partijen hebben aangegeven dat dit zal leiden tot minder emissies en zal helpen om een bijdrage te leveren aan het behoud van het milieu. Het is opgemerkt dat alle leverende partijen vinden dat het toepassen van CE-principes hun imago zal verbeteren om koploper te zijn. Leverende partijen kunnen profiteren van fiscale prikkels die door de Nederlandse overheid worden gegeven aan partijen die duurzame bouwpraktijken bevorderen, waardoor de inputkosten worden verlaagd. De leverende partijen geven ook aan dat CE hen toegang zal bieden tot kant-en-klare inputbronnen, wat de impact zal hebben van het verlagen van de inputkosten. Het is op te merken dat de bouwsector als een vragende en leverende partij zal profiteren van minder verbruik van primaire grondstoffen en natuurlijke hulpbronnen via CE.

Thema's voor CE	Bevindingen
FP1. Kansen voor samenwerking	Nieuwe ideeën genereren
FP2. Circulaire ambitie / innovatie ondergeschikt aan andere belangen	tijd- en financiële druk Terughoudendheid van klanten door hoge prijzen
FP3. Hoe circulaire ambitie / technologie eruit ziet en werkt	Gebaseerd op functionaliteit en prestaties
FP4. Onmisbaarheid van circulaire technologie / ambitie in de keten	Allen als het commercieel rendabel is en waarde toevoegt
FP5. Ervaren problemen binnen CE	Geen kwantitatieve maatstaven of meetinstrumenten om CE-effectiviteit te meten Geen wettelijk kader voor CE-implementatie Gebrek aan bewustzijn over CE Geen duidelijke verschillen tussen CE en duurzaamheid
FP6. Onmisbare partijen	Verschillende partijen voor elke partij
FP7. Circulaire inkoop	Eenvoudig demontabel Gebaseerd op% secundaire materialen MKI Functioneel aanbesteden DBFM of bouwteam Niet gebaseerd op prijs
FP8. Aanleiding voor samenwerking	Kostenbesparingen Toegevoegde waarde Verbeterde klanttevredenheid Milieubehoud Nieuwe werkgelegenheid
FP9. Nodige middelen	Beleid Kennis van andere partijen
FP10. Regierol	Verschillende partijen voor elke partij
FP11. Optimale samenwerking	Openheid en transparantie tussen alle stakeholders Winst delen Bereidwilligheid om risico's te nemen

Figuur 2: bevindingen uit de interviews (eigen ill.)

Obstakels

De administratieve druk is de belangrijkste reden voor het niet toepassen van CE door de vragende partijen. Geraedts et al., (2015) constateren dat bouwbedrijven onder druk staan van klanten die de projecten zo snel mogelijk willen afronden en van overheden die de groeiende vraag naar woningen en commerciële ruimte tegen te gaan. In een dergelijk scenario wordt het moeilijk om tijd en middelen te spenderen om CE-principes in bouwplannen op te nemen. Opgemerkt wordt dat alle leverende partijen vinden dat CE een nieuw concept is en nog steeds niet erg goed is ontwikkeld. Dit voorkomt dat ze CE kunnen gebruiken in hun projecten. Alle leverende partijen geven aan dat er een gebrek is aan samenwerking en coördinatie tussen de verschillende belanghebbenden bij bouwprojecten, waardoor het moeilijk is om CE op een samenhangende manier in elk project te implementeren. Het is opgemerkt dat vragende en leverende partijen onder druk staan van zowel de klanten als de overheid voor de snelle voltooiing van hun bouwprojecten. Dit maakt het moeilijk om CE-principes op te nemen in bouwprojecten. Een ander terugkerend thema is het gebrek aan bewustzijn en de onbekendheid van CE-adoptie in de bouwsector.

Uit de bevindingen van de primaire gegevensanalyse is geconcludeerd dat de volgende activiteiten het belangrijkst zijn in het versnellen van circulaire bouwprojecten: (a) een duidelijke definitie van circulaire economie met kwantitatieve circulaire indicatoren; (b) circulaire inkoop; (c) meer secundaire materialen beschikbaar maken en (d) regierol. Bovendien is, voor de overgang naar een volledig circulaire economie, samenwerking en coördinatie noodzakelijk tussen alle ketenpartijen in de bouwsector.

5. CONCLUSIE

Circulaire economie staat nog maar aan het begin van de transitie. Om volledig circulair te zijn, zijn alle partijen uit de keten nodig. Er zijn echter partijen die kunnen proberen een transitie te maken binnen hun eigen organisatie, binnen wat nu mogelijk is op het gebied van circulaire economie en onderscheidend worden. De grootste noodzaak voor de overgang naar de circulaire economie is om deze in de praktijk aan te pakken, zowel door de leverende als door de vragende partijen. Het creëren van vraag, wat zal resulteren in concurrentie en de momenteel (te) dure secundaire materialen, zal meer winst opleveren voor steeds meer partijen in de keten door massacreatie.

Circulaire economie heeft langetermijndenken nodig, waardoor de eisen voor materialen onzeker zijn. Zolang primaire materialen goedkoper zijn dan secundaire materialen, zal de voorkeur uitgaan naar nieuwe materialen. Dit kan worden tegengegaan door belasting te heffen op primaire materialen of door subsidie beschikbaar te stellen op

secundaire materialen. Het is echter alleen mogelijk als er voldoende secundaire materialen beschikbaar zijn. Een van de belangrijkste bronnen van niet-adoptie van CE is het gebrek aan overeenstemming over een geschikte definitie van CE voor de bouwsector. Dit kan het besluitvormingsproces in gevaar brengen en uiteindelijk leiden tot ineffectieve beleidsinterventies. Het succesvol implementeren van CE in de bouwsector heeft een definitie nodig die de hele keten bestrijkt om inzicht te verschaffen in de materiaalstromen in de economie. Dit zal een "gemeenschappelijk referentiekader" creëren om de voortgang te beoordelen ten opzichte van gestelde doelen en om de bron van ondoelmatig gebruik van middelen en kansen voor hulpbronnenefficiëntie te identificeren.

6. AANBEVELING

Er kunnen verschillende aanbevelingen worden gedaan aan de verschillende belanghebbenden in de bouwsector voor de overgang naar volledig CE. Vragende partijen worden aangeraden zich te committeren aan de circulaire economie, CE-gebaseerde inkoopprocessen te gebruiken en innovatie en samenwerking aan te moedigen. Aanbevolen wordt voor vragende en leverende partijen om klanten te adviseren m.b.t. CE, CE principes mee te nemen in het ontwerp van gebouwen, fabrikanten van bouwproducten te betrekken in het proces, etc. Aanbevelingen voor leverende partijen zijn onder meer het ontwikkelen van opties voor het einde van leven van bouwproducten, het ontwikkelen van retourschema's, zoals product als service, etc. De volledige aanbevelingen kunt u terugvinden in het onderzoek. De vraag is of er een duidelijke definitie zal zijn in de bouwsector, maar er moet enige richting zijn, leidraad voor een definitie van circulaire economie. Ook het creëren van bewustzijn van ketenpartijen is belangrijk om de voordelen van CE te relateren om het in de praktijk toe te passen. Zodra ze zich de voordelen van CE realiseren en hoe ze er winst uit kunnen halen, zal CE op gang komen.

GLOSSARY

BIM	Building Information Modeling
BREEAM	Building Research Establishment Environmental Assessment Method
DBFM	Design, Build, Finance and Maintain
ECI	Environmental Cost Indicator
EPB	Environmental performance of buildings
KPI	Key Performance Indicators
LCA	Life Cycle Analysis
MLCA	Multiple Life Cycle Analysis

CHAPTER 1. INTRODUCTION

In this chapter the motivation, problem definition, research question and the reading guide will be explained.

1.1. CIRCULAR ECONOMY

Circular, circularity, circular economy and circular procurement have been extensively discussed terms since the last few years and in the present. There are several reasons that have been given for the world to transition a linear economy to a circular economy (CE).

The exploitation of the world's natural resources is increasing. Fisher – Kowalski and Swilling (2011) stated that since the 1950's the world's consumption of raw materials and minerals has gone up by up to 35 and 30 times respectively, that of fossil fuels by 12 times and that of biomass materials 4 times. It is expected that the world's consumption of raw materials alone will triple in 2050 compared with 2000 (Fischer-Kowalski & Swilling, 2011). The linear economy approach we deal with raw materials is not future proof. The use of the linear economy has lead to environmental degradation, depletion of raw materials & other natural resources as well as excessive waste generation & greenhouse gas emissions. The consequence is that these raw materials will no longer be available to new generations (Nelissen, & Versteeg, 2016). The circular economy solves this problem by envisaging the use of waste as a raw material (Huysman, 2017). This implies that the circular economy is a positive and innovative solution to many of the problems generated by the linear economy.

This subject has boomed in recent years and there is tried to get clear and unambiguous definitions and concepts about circular economy. However, there is considerable confusion on what exactly is meant by a circular economy. This confusion is indicated by fact that there are as many as 114 different definitions of circular economy (Kirchherr, Reike & Hekkert, 2017). However, there is consensus amongst scholars like Geissdoerfer et al. (2017) and Schut et al. (2015) that the definition given by Ellen MacArthur Foundation (2012) is the most acceptable one. According to Ellen MacArthur Foundation (2012) Circular Economy refers to an business model for the world economy that is inherently regenerative. Its objectives include reconceptualization of the current understanding of 'end of life' product concept, promoting the use of renewable energy sources, eliminating usage of environmentally harmful chemicals and the elimination of waste through reuse, repair, recycling and the better design of products and systems.

According to MacArthur (2013), the circular economy is not a new concept. However, its greater acceptance and adoption will depend on re-engineering manufacturing practices and on changing current methods of product tracking, consumption and waste disposal.

While most research on circular economy has been performed in social and organisational innovations such as circular business models, production and consumption models, there is not much clarity on how circular innovative technologies or CIT can be leveraged in the construction sector. CIT includes reinterpreting how materials, processes and products in the construction sector get designed and used, how resources such as raw materials, water and energy get managed, how waste generation can be reduced or eliminated and methods of recycling and reusing waste.

These improving circular technological developments are drawing attention of both market parties and politics to the construction industry which is a significant consumer of resources on the one hand and which generates large amounts of waste on the other (Ortiz, Castells, & Sonnemann, 2009). According to Shut (2015), CE for the construction sector envisages joint collaborations between the construction sector and governments to reduce resource extraction and consumption as well as promote recycling and reuse of resources and materials.

Therefore this research aims to develop a guidance and a framework on the adoption of more circular innovative technologies in construction projects and to propose an approach that can support involved parties in order to realize more circular construction projects. Promoting the utilization of more circular innovative technologies in construction projects promises multiple benefits for the economy of the Netherlands. These primarily include (a) reduction in raw material imports, of consumption of water, of generation of environmentally degrading greenhouse gases like carbon-dioxide and (b) rejuvenating the Dutch economy by promoting annual savings of €7.4 billion on resource usage as well as creating 54,000 circular economy related jobs.

1.2 THE CONSTRUCTION INDUSTRY AND TRENDS

Shut (2015) observes that in circular construction, the projects are designed in a manner that promotes the high-quality reuse and recycling of materials used in every stage of the project. In addition, it involves the use of high-quality recycled products such that the integrity of materials used is maintained through the 50 to 100 years a building is expected to last. Experience can be gained by executing innovative projects (Rijkswaterstaat, 2015).

However construction industry is working on transition to circular economy. There are several new initiatives being developed in order to boost country's circular construction industry, such as material passport and National Environmental Performance database.

According to Visser (2017) a condition to circular construction economy is overview of materials. In order to reuse or recycle the materials or construction components efficiently, it is important to know how many materials and where in construction project there are available.

One of the critical gaps in the circular constructions are logistics systems that are cost efficient and user friendly because they boost the recycling and reuse of construction waste back into the construction sector (Damen, 2012). This presents an opportunity for the construction sector to develop large material banks containing high quality reusable waste materials (Ellen MacArthur Foundation, 2012). Also taking products back from consumers is a particularly cost-prohibitive problem. Rau (2015) presents a conceptual solution to the above problem by observing that waste reuse in the construction sector is still not happening due to lack of information related to waste. Once the construction sector is able to generate useful information related to waste, prevention of waste and enhanced value creation will occur.

Material Passport gives an overview of quality and amount of materials and construction components. The more materials and construction components included in material bank, the more chance that these materials and construction components will be reused (Visser, 2017).

Material Passport is a concept supervised and governed by the Madaster Foundation. The foundation promotes, stimulates and oversees the development and usage of the Material Passport and ensures privacy, security and availability of data (Madaster, nd). The rise of Material Passport and the use of RFID (Radio-Frequency identification) makes materials traceable throughout the supply chain. This gives insight into the origin, stock and performance of each material.

Policy regarding the National Environmental Performance database provides rules for quantifying environmental impacts. However amount of products that can be chosen in this database is very limited. Also many products are missing background information which makes is unclear whether the right product is chosen (Kuijpers-van Gaalen, 2017). Therefore there has to be a one clear database where an overview of materials and their environmental performance should be stated in order to make a right choice when designing and/or transforming of executing a construction project.

The construction sector is very unique and differentiated from all other sectors primarily because of multiple complexities associated with its primary product, i.e. the building. In addition, buildings are subject to more environmental and climatic conditions than any other product. Circular construction projects are designed in such a manner that their impact on the environment (or their environmental load) is minimized over their entire lifetime of the building (Khasreen et al.,2009). However, because buildings typically have long life-spans of 50 – 100 years, it is not possible to easily predict the environmental changes that the building will have to contend with or how materials used in its construction will change. In addition, buildings undergo repairs across their life-cycles as well as possibly, a change in their functions and it may not be possible to evaluate the impact of these changes on the environment in the long term (Khasreen et al. 2009). These problems are compounded by the fact that most decisions related to the circular nature of constructions must be made in the

design phase of the building process. It is for these reasons that builders avoid using circular construction concepts in their construction projects.

In march 2014 the kick-off of commodity Agreement of the Economic Board Utrecht took place. The goal of the initiative is to ensure 10 percent of the procurements by the Province of Utrecht will be circular by 2020 (Economic Board Utrecht, 2014). With this program the government takes responsibility for taking action regarding the attainment of the determined goals. Besides the role of market manager and network partner, the government wants to ensure promotion of the transition from an inviting perspective and systems approach. The focus lies on organizing direction and responsibilities (Nederland circulair in 2050, 2016).

The Government of the Netherlands officially launched its circular economy program in October 2016. The Dutch circular economy program is based on recommendations made by the Sociaal-economische Raad (SER) (or the Model Rules of Procedure for Works Councils) advisory report (Sociaal-economische Raad (SER), 2016, p 41).

This program took the form of a national plan and involved participation from different government departments located across the country for the effective implementation of the circular economy program. Therefore all chain partners from real estate owner, architect to demolisher must embrace the circular principles and circular innovative applications. The main objective of the Dutch circular economy program is to halve the current levels of primary resources being consumed in the Netherlands by 2030 and to transition the country to a fully circular economy by 2050. The achievement of these objectives however entails considerable investment in the circular economy, securing agreement from primary consumers on consumption of resources and a paradigm shift in areas related to procurement and waste disposal.

This circular innovation program presents a framework for innovation projects to exploit opportunities. This way a steady basis is created by not only focusing on increasing the knowledge level regarding CE, but also by understanding what is required to successfully transition from a current linear to a circular economy and the steps that need to be undertaken to speed up the process.

1.3 The Metropolitan Region of Amsterdam

A number of metropolitan areas in the Netherlands have their circular innovation program. One of the metropolitan areas is Amsterdam which is internationally a pioneer and is being followed by other cities in Europe and beyond. “The municipality of Amsterdam has committed to the circular economy as an important pillar of its sustainability policy, as apparent in its sustainability agenda” (TNO, 2012, p.9), adopted on 11 March 2015.

This is a good starting position, as confirmed by the objectives of the Dutch National Green Deal which is to turn ‘The Netherlands as circular hotspot’. The region has experimented with pilot programmes in the moving to a circular economy, but the municipality wants to commit to a real transition, and the efficient recovery of natural

resources and materials, within the construction sector is an important area of focus. As the municipality would also like to stimulate economic activity, research and innovation (TNO, 2012).

Figure 1.1: Vision of a circular construction chain in Amsterdam

The ambition to be a circular hotspot is widely supported in Amsterdam. Not only is the municipality progressive, but citizens and businesses are equally enthusiastic and energetic about moving to a circular economy. Amsterdam's vision of a circular construction chain will be further explained in Chapter 3.
The total economic activity of the Amsterdam metropolitan region amounts to 106 billion euro annually, of which 47 billion is accounted for by the city of Amsterdam (CBS, 2015) and 1.7 billion euro by the construction industry per year. Amsterdam has plans to realise 70 thousand new homes by 2040 (Amsterdam, 2011). Part of this new construction is replacing existing homes that have been demolished and another part is accommodating the growth of the city. The results provide insight into the effects of implementing these strategies on economic growth, employment, material savings and reduction in greenhouse gas emissions.

In circular program of the metropolitan region of Amsterdam, more focus is on smarter demolition. During the demolition of buildings, re-usable products and materials are separated, while maintaining their physical characteristics and economic

value. During the separation, there is a special location (unused land close to construction sites, for example) for storing materials that will be used directly in the construction of new buildings and renovation of older structures. To support this, a materials database is required, which is linked to an online marketplace, where buyers can easily exchange these materials on the basis of quality and quantity.

“Amsterdam wants to be the front-runner in circularity, and the metropolitan region of Amsterdam is in a good starting position for transitioning to a circular economy” (TNO, 2012, p.9). The region has many entrepreneurial and innovative businesses, citizens, start-ups, organizations and knowledge institutions that are already working within the framework of a circular economy.

1.4 Problem definition

Despite all these interventions in practice an enormous discrepancy exists between parties offering circular innovative technologies (CIT) on the one side, and actual execution of these CITs on the other side.

Problem statement: CE has not been embraced by the construction industry.

Preliminary literature research shows that for constructions projects a few examples of circular buildings and infrastructure exist. There are only a few completely circular buildings in the world (Oeffelt, 2017). The reason for this problem lies in fragmented knowledge management, the absence of information exchanges related to circular economy, lack of coherent training and skill development, limited knowledge exchanges between businesses, and the limited distribution of that knowledge between stakeholders (Het Groene Brein, 2015). Therefore there is little expertise, knowledge and experience in applying CIT in construction projects.

The following factors can play an important role in aforementioned problem statement:

1.4.1 Not a one central definition for circular construction

In order to enable an acceleration of circular economy in construction, it is important that all parties look at the same direction. A clear definition could be that supply chain companies can base their circular goals on. At the moment there is a difference on what supply companies understand by the concept of circular construction. For supply chain companies, some elements of circular construction may be the same, but there is not a one central, total concept for circular construction. Some supply chain companies have not heard of circular building before, or they are not aware of the possible implementations of it (de Rijk, 2017).

Figure 1.2: Status of Circular Economy Awareness in the construction industry (Adams, Osmani, Thorpe, & Thornback, 2017, p.40)

Adams, Osmani, Thorpe & Thornback (2017) conducted a survey in the construction sector. The respondents were required to indicate their level of awareness about the circular economy along a continuum of scores ranging from '1' which stood for 'Completely Unaware' to '4' which stood for 'Completely Aware'. It was found that most of the respondents were not aware of circular economy or even of the concept of a circular economy and what it represented. This indicates that greater advocacy for circular economy within the construction sector is dependent on a creating a clear and transparent understanding of the concept amongst various stakeholders leading to greater levels of adoption of circular economy in the construction sector.

Also according to research of de Rijk (2017) some supply chain companies think that they are already implementing circular economy by energy saving measurements and the reduction or separation of waste, such as reducing transport movements or placing different waste containers at the construction site.

Therefore there is a need for a clear definition for circular construction. First of all, this is important for the regional business community to work effectively with circular construction. Besides that, the awareness of potential clients is also important: the demand for circular construction can only arise when it is clear what exactly it is and what is being associated with it. Finally, clear definition for circular construction is important in order to losing its value and becoming a container notion.

1.4.2 Involved parties in circular construction projects

To speed up the transition to circular economy by adopting circular innovative applications, efforts by all involved parties are needed throughout the process, as it can be seen in the figure below.

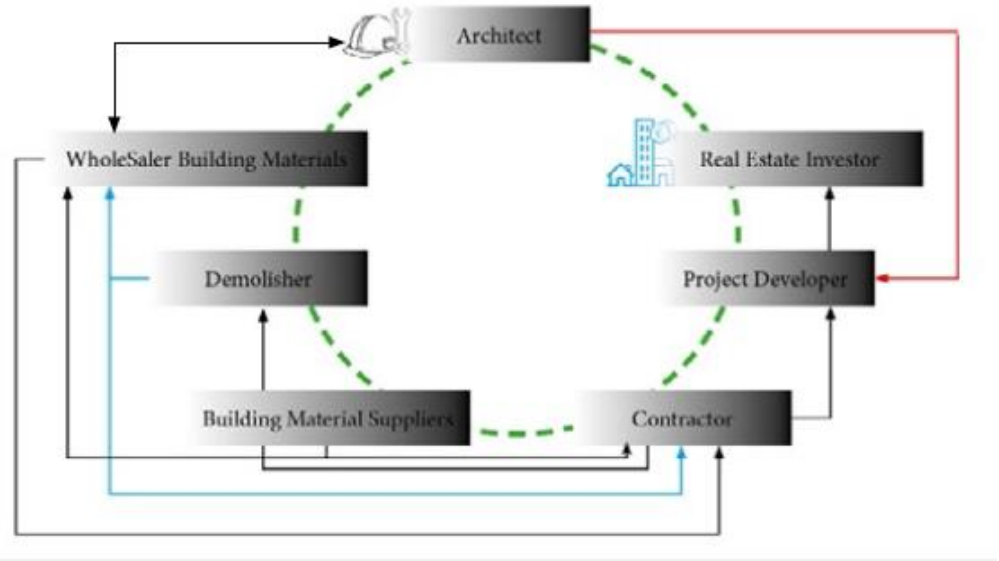

Figure 1.3: Overview of involved stakeholders in Circular Construction Economy (own ill. adapted from ING Economics Department, 2015)

Architects and real estate owners make a choice whether an old building can be reused or demolished. Building suppliers offer materials. Demolishers can offer high quality reusable construction materials by smart dismantling. Wholesalers can fulfill the role of a raw material bank distributing used materials (ING Economics Department, 2015).

Also through procurement within the circular economy - circular procurement - the public sector could be frontrunner in a transition towards a circular economy, while being an example for the market at the same time. In the recent published report 'Ondernemen in de circulaire economie' (Eng: Undertaking in the circular economy) of the MVO Netherlands the assumption is made that governmental procurers could become 'launching customers' of the circular economy (Schoolderman, Dungen, Beukel, Raak, Loorbach, Eijk, & Joustra, 2014). However, this does not mean that suppliers or contractors have to wait until the client is going to put these innovative requirements in their procurement process. By taking initiative and offering their CIA on the market a.o. contractors can make it is possible to distinguish themselves from other contractors. Therefore knowledge exchange about availability of CIT and implementation methodologies of these CITs among involved stakeholders is very important in order to embrace the circular innovative technologies. Damen (2012) observed that issues related to confidentiality and trust prevent transparent information exchanges in the construction sector. Romero and Molina (2009) found that it is very difficult for value co-creation to happen in the construction sector.

1.4.3 Circular Innovation in Procurement

In order to enable the entire chain to provide circular innovative applications, clients can do a tender inquiry in broad terms which requirements a building or a construction project must meet instead of a procurement where all specifications are

set in stone. Each chain partner can offer their circular innovative applications and building methodologies instead of these being imposed.

According to Fijneman (2016, p.2) “both for the contractors and the client there is more room needed for technical innovations in procurement. For contractors, it means that it is possible to distinguish from other contractors. For customers, it offers the chance to be surprised with innovative solutions.” Projects where this happens, tenderers often come up with even better environmental performance than minimally asked. For example, at the procurement of the Alliander headquarters, the demand was that this building would become an energy-neutral building. However VolkerWessels surprised the client by proposing an energy-efficient building (ING Economics Department, 2015).

These views suggest that circular procurement is an important factor that impacts the adoption of CIT by various government departments. Circular procurement is a concept that requires a complete re-conceptualizing of traditional notions of demand, supply and ownership. Performance is given a very high priority in circular procurement. It also incorporates such contemporary revenue models such as product – as – a –service (Pianoo Expertisecentrum Aanbesteden, nd).

1.4.4 Economic barrier

When comparing the price ratio of virgin vs. secondary resources the prices of raw materials are fickle. At low prices alternative, secondary resources (of good quality) are not competitive.

When the materials are reused, they have to be tested on a.o fire safety, constructive safety. These tests makes reused materials become so expensive that using a new (virgin) material would be economically advantageous (Visser, 2017).

Another barrier of reusing of building materials is the current conventional construction style, which makes it difficult and costly to recycle materials and components, for example, because they are merged. In this case down cycling to raw material is often the only option.

In summary, the movement of the linear to circular economy characterized by multiple closed loops will not happen without considerable changes in modes of operating. All the stakeholders involved – such as government authorities, business houses, educational institutions, citizens etc must take action in order to make the circular economy a reality. Integration between different policy levels and policy domains will also be key to achieve the stated goals. Businesses often lack information on opportunities to become a closed loop, circular economy business.

In order to tackle the aforementioned problem a theory called Service Dominant Logic (SDL) will be introduced. The concept of SDL was first proposed by the economist Frederic Bastiat ((1964, pp. 161-162). According to Bastiat (1964), the exchange of services is accompanied by the simultaneous exchange and deployment of various

skills and competencies of all stakeholders involved in the transaction. This theory is based on eleven foundational premises.

According to SDL theory, it is not exchange of goods that characterize most commercial transactions today as much as that of ideas, knowledge and expertise. Transfer of these intangible elements can be done directly through education and training or indirectly by incorporating them into objects and projects. SDL becomes a tool that promotes various kinds of tangible and intangible innovation. These new products can then be leveraged to provide different services. This also implies to SDL's quality as a framework to explain innovations and their applications (Lusch and Vargo 2004, 2006, 2008).

1.5 Research objectives and research questions

Given all these descriptions, this research aims to develop an approach that helps organizations to implement in the construction sector to promote the utilization of circular innovative technologies.

This research develops a framework that indicates how stakeholders in the construction sector must incorporate circular economy concepts in construction projects. It extends the concepts of circular economy and provides an understanding of success factors that lead to effective implementation of circular construction projects.

This framework will provide an understanding of the conditions necessary for promoting a circular economy in construction industry. To understand what is needed to be able to adopt circular innovations in construction industry. Also to explore what the partners in the construction chain need from each other to realize their circular ambition(s).

In order to achieve the above objectives, the following research question needs will be answered in this thesis.

Main research question:

What do the supply chain parties in the construction industry need in order to adopt Circular innovative technologies to realize their circular ambitions?

In order to answer above mentioned main research question, secondary research questions has been formulated. To answer to the main question some preliminary knowledge is needed. Therefore, the following questions:

1. How could circular innovative technologies be adopted between construction supply chain parties to realize the circular ambitions of the metropolitan region of Amsterdam?
2. How does Service Dominant Logic theorize that the interaction should be

between parties in a region in order to realize the circular ambitions and adoption of CITs?

3. How do parties in the construction supply chain follow the Service Dominant Logic in realizing the circular ambitions of the metropolitan region of Amsterdam?
4. What can the metropolitan region of Amsterdam learn from the Service Dominant Logic approach in adopting CITs and becoming circular in the construction supply chain?

Identifying answers to the research sub-question will lead to the main research question getting clarified. This in turn will lead to recommendations on how supply chain partners in the construction sector can adopt circular economy practices.

1.6 Research Design and Reading Guide

This research is organized such that each research question is executed by an intermediate research step. A brief explanation of overall process is as follows:

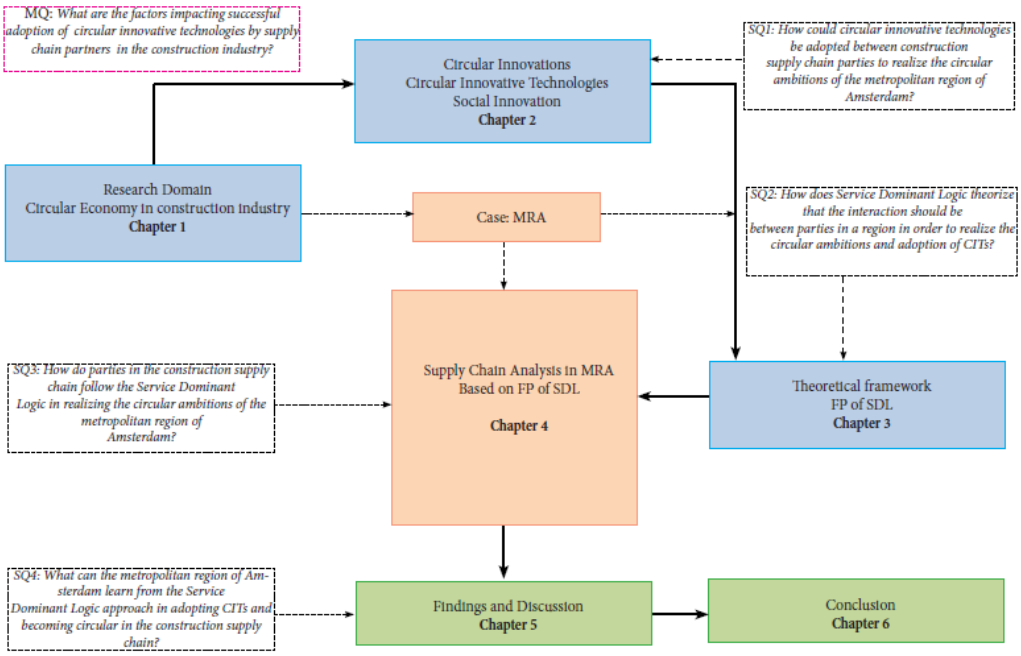

Figure 1.6.1: Research structure (own ill.)

Chapter 1: Introduction which provides an introduction to the research domain, i.e. circular economy and the concepts unique to circular economy in the construction sector. *Chapter 2: Circular Innovations* is the literature review that explores different circular innovative technologies related to movement of linear to circular economy.

In *Chapter 3: Theoretical framework* is presented. The framework is formulated from SDL or Service Dominant Logic theory (Vargo, & Lusch, 2004; 2008; 2016). Service-dominant logic is based on the concept of value co-creation. Value is in this case

circular ambitions and the realization of these ambitions can be seen as service. This chapter also describes which of the eleven basic concepts of Service Dominant Logic: co-creation process, knowledge exchange process etc. is visible or needed in order to realize circular ambitions. The relationships between all these foundational premises and between the different findings from the interviews will be explored in this chapter.

Chapter 4: Supply chain Analysis in MRA contains the analysis based on interviews with different stakeholders and main findings will be explained**.** *Chapter 5: Findings and Discussion* explains what the findings might mean, what the barriers and opportunities are for the main findings. *Chapter 6: Conclusion* contains the conclusion and reflects on the research and validation of the framework and provides recommendations for further research.

1.7 RESEARCH METHODOLOGY

To answer the research questions, it was necessary to gather information in different ways: literature research and interviews. In addition to literature research practice literature from advisory organizations such as PIANOo, MVO Nederland, Ellen MacArthur foundation, ING and ABN Amro. Due to the lack of written knowledge and objective information regarding the circular economy, the big part of the collected information is obtained from interviews and the realized circular projects.

Application of eleven foundational premises of SDL in construction industry will be executed and based on these premises interview questions will be composed to understand which conditions there are needed to realize circular ambitions. Interview questions will be developed in such a way that the answers could help to identify the SDL's foundational premises. Also the same questions will be answered to the different supply chain parties. In order to investigate these eleven themes there is chosen for the metropolitan region of Amsterdam, which wants be internationally a pioneer, puts a clear focus on circular economy in this region and have their circular building program. MRA also have a good overview of what they want. Despite of these the question how they are going to tackle their ambitions remains. The interview is held between the parties within the metropolitan region of Amsterdam. After analyzing the interviews the main findings/main activities that can support parties to make a transition to circular economy will be discussed.

CHAPTER 2. CIRCULAR INNOVATIONS IN CONSTRUCTION INDUSTRY

The shift from linear to a circular economy in the construction sector requires innovation. Buildings require a smart design to be able to efficiently dismantle and separate residual flows. In addition, there is a need for circular material choices, which are designed to be lighter and smarter, have no synthetic additives and, have a longer life span (ABN Amro, 2014). There is also a need for a marketplace and a material bank for parties where demand and supply can be brought together to provide high-quality reuse of materials and components.

2.1 CIRCULAR INNOVATIVE TECHNOLOGIES

The most basic concept related to CE is that of closed material circles or loops. Cheshire (2015) observed that the concept of closed loops is innovative and its adoption and implementation is critical for the implementation of CE in the real world. Closed loop concept refer to a different method of doing business. It represents a different way of thinking from a linear economy which is based on extracting raw materials from the earth, converting them into products and disposing of them as waste at the end of their useful life. Instead, according to the closed loop concept, materials must be designed, manufactured and used in a way that results in their getting recirculated into the economic systems. In this way 'zero' waste gets generated and raw material resources get conserved. It may be inferred here that the closed loop economy is very different from the linear economy.

The magnitude and scope of the differences of a circular economy from a linear one, requires the adoption of a broad concept of innovation in both public and business policies. In order to redress the difficulties of adopting CE in different phases of the product life cycle, it will be necessary to support the generation of knowledge in all fields – including the social sciences; to promote its application in the development of new technologies, and to apply existing technologies. It is important therefore to understand the level of innovation needed in order to stimulate the transition from linear to circular economy in construction projects. Besides the importance of new ways of thinking and collaboration, new designs and design techniques/ methodologies are also necessary (Ghisellini, Cialani, & Ulgiati, 2016). Construction projects require efficient design in order to disassemble and separate the materials. In addition, there is need for circular material choices, which makes lighter and smarter designs possible (ABN Amro, 2014).

Scarcity of raw materials and amount of CO2- emissions has led to development of new technologies. By innovation and new techniques new materials have been available. Materials such as paper, cardboard, fibers are materials that has been used extensively, however new technologies make it possible to lower the extraction and

use of raw materials and CO2 emissions. Alternative materials and complete new applications of these materials are possible (Gemeente Amsterdam, 2016).

The Accenture researchers, Lacy, & Rutqvist (2016) composed a list of 10 digital, engineering and hybrid technologies for disruption of our current linear economy to bring in the new circular economy. These are:
1. Digital technologies the reduce consumption of products like paper that are in turn based on natural resources like wood.
2. Automated / digital communication systems.
3. Distributed cloud based computing
4. Leveraging social media for business purposes.
5. Analytics for efficient processing of big data.
6. Modularly designed products, so that when products break down, only the defective modules need to be replaced.
7. Sophisticated and contemporary recycling technologies.
8. Technologies based on life and material sciences.
9. Product Tracing, Identification and Return Systems that make it cost-effective to collect used /waste products and return them back into the economic system.
10. 3D printing (p.6).

There are many different technical innovations in order to build circular. In addition to aforementioned technologies, ING Economics Department (2015) introduced following circular innovative technologies:
· Flexible Circular Design
· Maximize the life cycle of construction projects
· Design for disassembly
· Design with less materials
These circular innovative technologies will be further explained.

2.2 Circular Design

Circular Design means a building or infrastructure is designed in such a way (1) that it consists of detachable components, such as facades, windows, doors, floors and construction elements. In addition, the raw materials (2) must be easily recycled. Also disconnecting architectural features from the constructive structure, (3) enhances the adaptability of the building (ABN Amro, 2014).

2.2.1 Design for disassembly

According to Lacy and Rutqvist (2016), modular product design are not just about new changes in the way products are designed, used and function but also refers to new paradigms of product – customer relationships. Thus when a product made of different modules breaks down, only the defective module is changed. This extends the relevance of the product to users and the overall length or duration of its use.

An example for this, could be Park 20/20. In this project there are as much as possible C2C materials are used and it is designed in such a way that the parts of this project can easily be disassembled.

2.2.2. The concept of 'Product Reuse'

The concepts of repurposing and redesigning of products involves using old product parts to create new products that can be used in new ways.

2.2.3 Flexible/Adaptable Design

A building can be designed a manner that alters its function over time, or adapt to a changing demand or need of the user. Making assets multifunctional makes for a robust earnings model. This is also the case with infrastructure construction.

For example, adopting two lane highways to four lane highways depending on the trends on extensive car use or a speed level.

2.3 Circular material selection

One of the ways to achieve circularity in the construction sector is to leverage material sciences to promote materials substitution on a larger scale. This will result in the discovery of new and innovative methods of converting waste products into inputs for the construction sector. These input materials form 'substitutes' for primary raw materials hitherto being used in the construction sector, resulting in resource conservation.

Circular building materials provide as few negative effects as possible throughout the life cycle and do not have an effect on man and the environment (Akadiri, Chinyio, & Olomolaiye, 2012). Conscious material selection is important to reduce the life-cycle impact, extend the life span of materials and increase their reusability. The importance of material choices becomes clear when looking at the potential benefits:

- smarter

- lighter
- longer lifespan
- no synthetic additives

Materials used in the construction sector contain poisonous compounds that are non-biodegradable and potentially cause problems for humans and the environment. Acrylic, lacquering and staining often contain harmful solvents. There is a growing range of harmless biodegradable paint. Also, there are bricks and cement consisting of sand and microorganisms. Compared to the production of concrete, it costs only one sixth of the energy consumption to make this material. In addition, it is completely biodegradable (ABN Amro, 2014).

2.4 ADVANCED RECYCLING TECHNOLOGY

In construction industry only some examples of advanced recycling technology have been identified, such as tiles and furniture in new traffic control station in Utrecht in 2015 that could be dismantled for 100% and recycled for 96% (Pianoo Expertisecentrum Aanbesteden, nd). Another example is construction of Villa Welpeloo in 2005 from 60% salvaged material, the wood is derived from old cable reels. The steel used in the construction was procured from machines used in the textile industry. There were many such machines lying unused in factories in the Enschede province of the Netherlands which was once a textile hub, and where the house is located.

Villa Welpeloo located in Enschede

Bus Boarder Platform, Barcelona

One of the few examples for circular infrastructure project is Bus Boarder Platform (BBP) that has been developed in Barcelona by manufacturer called ZICLA. Besides Barcelona BBP have already been installed in Spain, Reims, Strasbourg and France.

The platform is made of PVC plastic that is highly resistant and durable. This is an example of a high quality recycled product that was wholly obtained from waste electric cable sheaths, pipes and hoses. The ZICLA platform was used to create 265 bus-stops over the period 2010 – 2015 and involved the use of 365 tons of recycled

plastic. Producing an equivalent quantity of fresh plastic would have generated upto 690 tons of carbon dioxide (Ellen MacArthur Foundation, 2016). These are one of the first steps towards the integration of circular innovative applications in construction projects. However there are not many construction projects where these circular innovative applications have been implemented.

2.5 Social innovation

In addition to the importance of new designs and techniques, there is the requirement for innovative methods of thinking and working together. Lack of Social Innovation could be the cause of the fact that organizations cannot keep up with the speed of technology development. Another essential component of Social Innovation is value creation in the social domain.

In the concept of social innovation, besides the organizational side of sustainability, attention is also paid to social value creation. Social innovation is the domain of human interaction. Talents and needs develop in these mutual relationships and networks. organizations motivate each other. Organizations appeal to the needs of clients or other parties and use each others' talents (Evans, Vladimirova, Holgado, Van Fossen, Yang, Silva, & Barlow, 2017). Volberda et al. (2006) divides innovation into two main groups and indicates that 75% of social innovation determines innovation success and acts as a leverage factor for technological innovation. Volderda et al., (2006) defined social innovation in terms of leveraging contemporary and modern management competencies and as the output of flexible organizational structures and better manager – subordinate relationships that lead to those forms of working that improved organizational competitiveness and productivity.

Important aspects of the three components of social innovation are; 1) Working smarter with the aspects of knowledge sharing, honest communication climate, developing and activating knowledge and rewarding on the basis of team performance, 2) Dynamic management with the aspects responding to creativity, working with cross functional teams, appreciative approach for employees, 3) Flexible organization, with aspects of internal change speed, separating innovation and effectiveness in work, working with a flexible employees and the self-organization aspect where the team takes ownership and responsibilities.

All in all, it can be concluded that sustainable innovation and collaboration in construction is not easy. Circular innovative technology is the result of the behavior of actors, and these actors are (partly) driven by the environment in which they operate. This means that change and innovation is not easy to manage by, for example, raising prices or stimulating cooperation. Circular innovative technology is outcome of complex, sophisticated and dynamic processes between various stakeholders who may or may not want something, and circumstances that may or may not be conducive to this (TNO, 2012).

CHAPTER 3. SERVICE DOMINANT LOGIC

In order to tackle the aforementioned problem a theory called Service Dominant Logic (SDL) will be introduced in this chapter. The concept of SDL was first formulated by the economist Frederic Bastiat. According to Bastiat (1964), all economic systems are based on the exchange of services. This is a radical new concept because of the common perception that economic systems are based on the exchange of goods and products. SDL's basic premise was that all actors in an economic system exchange different skills and competencies whilst exchanging services in the economic system and that these transactions are governed by 11 key drivers (foundational premises). The units of exchange in SDL's service based economy include ideas, information, knowledge, skills and competencies. These units can be exchanged directly through education and training or by incorporating them as part of products.

SDL theory then, focuses on the exchange of services rather than on manufacture, supply and distribution of tangible products. In the service based economy, one party

uses his / her skills, knowledge, competencies and expertise to benefit another party. According to Lusch and Vargo (2008), innovation becomes very important in a services based economy. In this economy, even tangible products and goods are leveraged to facilitate exchange of services.

Indeed, researchers like Chesbrough (2003), and Nambisan, & Sawhney (2007) as cited in (Mas-Verdú, Ortiz-Miranda, & García-Álvarez-Coque, 2016, p. 5325) point out that the manner in which supply chain companies manage innovation has changed dramatically over the period 2006 – 2016. Firstly, innovation no longer takes place internally and in the isolation of intra-organizational boundaries. Rather, Chesbrough (2003) said that innovation is a collaborative process between an organization and external players such as vendor partners, suppliers and even customers and competitors of the organization. A second distinguishing of contemporary innovation is that it relates not just to exchanges of tangible goods but also of explicit and implicit information or data amongst different beneficiary parties (Michel et al., 2008).

From the above views it can be inferred that SDL theory with its new and revolutionary concepts is an appropriate theory that can be used to better understand those value creating processes of innovation that characterize a circular economy.

3.1 Conceptualization of the theory

In order to create an interview protocol the SDL theory will be used, which refers to how interactions between the chain partners must be shaped/organized. If there are no interactions between the parties there will also not be a cooperation in the chain.

This theory emphasizes the link between creating and delivering value, because it is about creating a value proposition. It makes this theory suitable for this research, because the parties have to start supplying and building their services based on the possible innovations.

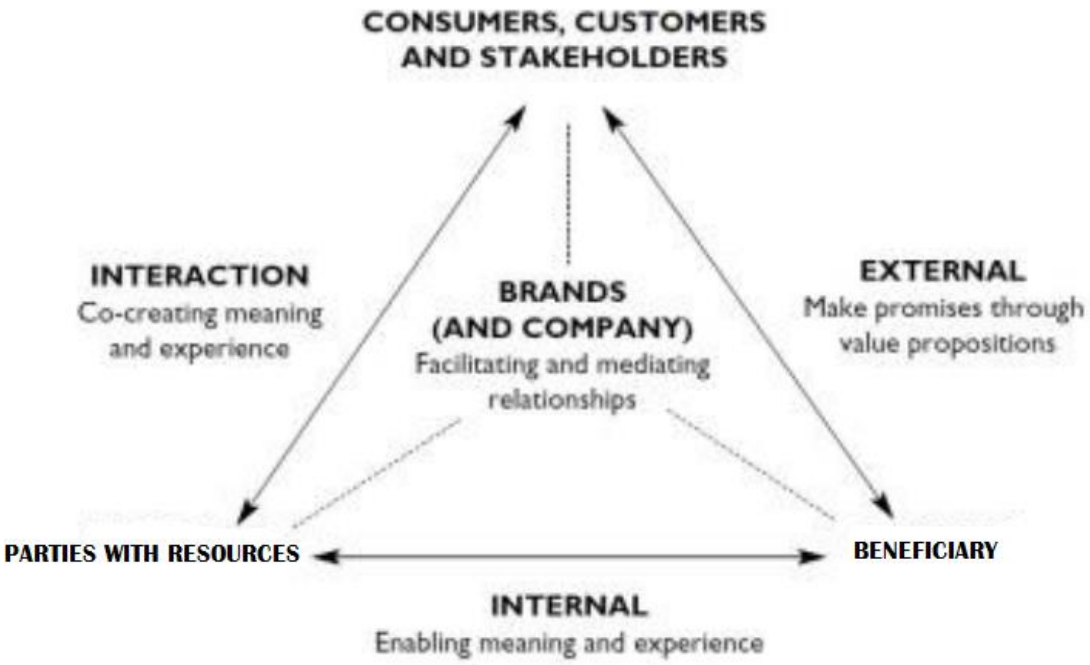

Figure 3.1: Conceptualization of SDL, adopted from Brodie, Glynn, & Little (2006).

SDL is about the process of creating activities and the process of delivering activities. This process starts with the "**Parties with resources**", which is also so-called parties with circular innovations, that can be a new material, that can be a technique, it can be a working method. These are the resources towards promoting circular economy in construction. They get involved in the chain in two ways: they help to create value, they enter into dialogue or interact with a requesting party/client, also called **"Beneficiary"**. The demand/request arises from ambitions they have regarding the circular economy. The beneficiary has a certain ambition with a circular economy, they give them a form and how that manifests itself in a service **"Value proposition"**. Value proposition is being negotiated with a party that has an innovation and how this innovation can help to realize circular ambition /demand. What comes in between those negotiations/ value proposition are **other parties**, which could be residents or interests of other parties that also have to be included in value proposition and negotiations. If these value propositions have been made then it is clear which circular innovation aims/can to deliver a certain value/service.

3.2 Interpretations of 11 foundational premises to construction industry

This paper extends the findings of researchers such as Vargo and Lusch (2008), Lusch, Vargo and O'Brien (2007), Vargo, Maglio and Akaka (2008) on SDL theory to the construction industry. This section will demonstrate through the use of related examples, how the 11 fundamental principles (FP's) that underlie SDL theory may be extended to the construction sector.

FP1. Service is the fundamental basis of exchange

The most fundamental and basic principle in an SDL is that 'services' are the primary value creating processes in an economic system. Services refer to those mutually beneficial processes occurring amongst different parties or agents in an economic system. Cesaroni (2013) observes that some of these parties use operant resources like knowledge, skills and expertise to create a service for exchange. These services are traded or exchanged amongst different beneficiaries according to their needs and requirements and in the process create more value within the economic system (Melancon, Griffith, Noble & Chen, 2010).

The process of creating a service and the value of that service to the economic system is dependent on the capability of the different players involved to innovate. To that extent the creation and exchange of services is the output of innovative activity. This can be innovative activities that lead to the creation of a tangible product or intangible knowledge. To the extent such activities are able to solve practical problems efficiently or meet customer needs and requirements more effectively, the more innovative and value creating they may be considered to be. Value creation then becomes a function of how effectively an innovative idea can be creatively adopted and implemented by different actors in the economic system.

> For example, if a contract has a certain new construction concept, which allows to use less materials. This fits within the ambitions of the clients to use less materials, lighter constructions. On the side of producers and suppliers, by opting for this innovative construction method, they can make other products special for this contractor.

In their role as contractor and as client, a contractor can bring the supply chain together.

FP2. Indirect exchange masks the fundamental basis of exchange

Considering more value-creating options, there could be other interests that can subordinate circular innovative technologies or circular ambitions. Ceasroni (2013) observed that the fact that it is services that get exchanged in an economic system can be masked by the goods, processes, capital, organizations and marketing systems that surround the transaction.

For example, the producers sometimes have no interest in making a product in a certain way, because their product is going to be used less, or fewer construction supply chain companies will use it.

FP3. Goods are distribution mechanisms for service provision

FP3 indicates the role accorded to tangible physical products in an economic system. The goods are subordinate to the service within the SDL. This means that everything that is tangible is only there to provide service.

For example, translated this FP to CIT, the service should be more focused on an ambition, such as reducing CO_2 or using less material. So the circular objectives and ambitions should be visible in the tangible elements of CIT (such as filter installation) and this tangible elements should play a role in realizing the circular ambitions, such as CO_2 reduction.

FP4. Operant resources are the fundamental source of strategic benefit

Knowledge and expertise related to the application of CIT of one organization is the basic factor in creating strategic benefits in realizing circular construction projects and differentiates them from competitors.

For example, the contractor has a strategic interest in its product / CIT. The knowledge that he has is of a big importance to him. He is the only one who delivers that service, or the construction method (unique selling point).

However it is possible that the contractor does not want to be the only one in the supply chain with this circular innovative technology, as a result where suppliers will be able to produce products not only for this particular contractor, but for many more contractors. This way there will be more contractors demanding these products from suppliers, which can stimulate the suppliers to make a certain product. When the contractor realizes that he is more willing to share his knowledge with other contractors.

FP5. All economies are service economies

According to this premise, the basic principle behind creating those services that add value to an economic system due to their problem solving capabilities and their ability to enhance productivity and satisfy needs is 'Innovation'. Thus, the ability to innovate lies at the heart of all service based economies.

Problem solving and efficiency enhancement is dependent on knowing what problems the parties in the supply chain encounter and what they need to realize their circular ambitions or adopt their circular innovative technologies.

FP6. Value is co-created by multiple actors, always including the beneficiary

This premise is based on the principle of co-creation of value where multiple parties must be involved, which could be the suppliers, an architect etc. But who certainly needs to be involved is the person who receives service, the beneficiary. There are at least 2 parties present and one of them being the beneficiary, who receives the service.

Therefore it is important to know which parties are considered essential and which parties should be involved according to the supply chain.

FP7. Actors cannot deliver value but can participate in the creation and offering of value propositions

According to this premise, value creation cannot be generated by any one actor or party. Rather, value creation is a collaborative process. One party ideates and formulates an innovative idea. This idea has value insofar as it is acceptable to other parties in the system and on its ability to solve problems and fulfill needs. This innovate idea then gets further developed, resulting in a service that gets consumed. Developing a value proposition is about communicating how the innovative idea and solution will impact other actors in the economic system. The value proposition must be appealing enough to other actors (particularly those who are going to be benefited from it). (Lusch & Webster, 2011). This implies that developing a value proposition refers to those processes of transparent dialogue where some actors state what they want or require and the other actors state how they can fulfill that need or requirement by creating innovative services.

> For example, the contractor think that the procurement process for circular projects should be different than “regular” construction projects. However the clients find it difficult to create a procurement process/contract. Therefore a proposal can be done by the contractors, who cannot deliver such a procurement process/contract but have an idea how it can be formulated, which elements should be included.

FP8. A service-centered view is inherently beneficiary oriented and relational

This premise is based on the principle that it is consumers who decide whether an innovation has value or not based on how beneficial it is to them. This suggests that even construction projects must be oriented not just on the building but on customer needs / requirements and on establishing relationships with them. According to SDL theory, collaborative processes that result in value creating services are based on interpersonal relationships. Guo and Ng (2011) observe that such collaborative processes are required in any process of innovation as it results in identification of defects in the service or service delivery mechanisms that can be rectified by the service provided. This in turn results in the creation of an enhanced service with improved ability to fulfill customer demand. For this FP it is important to know what

the main factors that will secure the co-operation of supply chain partners and the areas in which they are expected to collaborate.

FP9. All social and economic actors are resource integrators

This principle first acknowledges the fact that there are multiple parties in an economic system. Lusch and Webster (2011) classified all parties in an economic system as social and economic parties. These parties must collaborate together, integrating their resources to co-develop mutually beneficial innovations. This implies that even the service providers in the construction sector must work along with builders and with each other, combining their resources to develop mutually beneficial services. The advantage of these collaborative processes is that each party contributes knowledge, resources and competencies that are unique and possibly not possessed by other parties (Cesaroni, 2013). These different contributions then result in an innovation that has maximum benefit for all the parties involved.

FP10. Value is always uniquely and phenomenologically determined by the beneficiary

According to this premise, while a service provider may develop a service, it's worth or value in the market is always determined by the beneficiary. Value in turn is dependenting on the specific situations of different beneficiaries and on their needs and requirements based on that situation (Cesaroni, 2013). This implies that the service must be dynamic and adaptable as the external market situations of the beneficiaries are subject to constant change. Thus a new service can have value only in situational contexts when it can be practically applied and become a possible solution to problems being faced by the beneficiary.

FP11. Value co-creation is coordinated through actor-generated institutions and institutional arrangements

According to FP11, value co-creation does not occur through random processes of collaboration occurring amongst different parties in an economic system. Rather it is the outcome of properly co-ordinated collaborative processes amongst related parties and the institutions to which they belong.

> For example, if there is a interaction has been performed that after this conversation is decided to deliver a CO_2 neutral project, it is realized by actor generated institutions. If it is realized in advance by the parties that there should be a CO_2 neutral project, then the interaction is organized by institutional arrangements.

Conclusion

The 11 foundational principles discussed above form the base of SDL theory. Vargo and Lusch (2007) observed that a combination of these principles can be used by various sectors in order to enhance ideation and those value creating services that

lead to sustainable competitive advantage. These principles will be accordingly extended for the construction sector.

This thesis is unique in that it extends SDL theory to CE in the construction sector. This marks a departure from previous approaches to understanding CE which were focused more on products and materials being used in the construction industry. SDL theory on the other hand focuses on those new and innovative services that must be developed by all demanders, suppliers and demanders & suppliers which will facilitate the adoption of CE in the construction sector.

The eleven premised of SDL are translated to construction sector as it can be seen table below. Overview is given how to apply SDL to construction sector and recognition points/ themes are composed.

Interpretation of SDL's foundational premises to construction industry

SDL's Foundational Premise	Application to construction industry	Themes/Premises for CE
FP1.Service is the fundamental basis of exchange.	The ultimate goal of application of circular innovative technologies is the generation of new technological knowledge, which represents the essence of service. Exchanging the skill(s) and knowledge regarding CIT to realize Circular Construction projects.	**Opportunities for cooperation**
FP2.Indirect exchange masks the fundamental basis of exchange.	Service is construction industry is very complex due to the combination of goods, money and different institutions and therefore difficult the manage during consumer/provider interactions. Other activities within the construction project mask the ultimate goal of the innovative activity.	Circular ambition/innovation subordinate to other interests
FP3.Goods are distribution mechanisms for service provision.	Even though circular innovative technologies are transformed in tangible products (buildings or roads), the transfer of a.o technological knowledge to users remains the essence of the service (circular buildings = less CO2 emissions). Fysieke element/oplossingen om een circulaire doelstelling/ service te leveren.	How circular ambition/technology looks like and works (case studies and circular policy)
FP4. Operant resources are the fundamental source of strategic benefit.	The "know-how" regarding the application of CIT of one organization is the fundamental source of strategic advantage in realizing circular construction projects and differentiates them from competition.	Indispensability of circular technology/ambition in the supply chain
FP5. All economies are service economies	Innovative activity represents a technology based service aimed at solving practical problems, increasing efficiency and productivity.	Experienced problems within CE

SDL's Foundational Premise	Application to construction industry	Themes/Premises for CE
FP6. Value is cocreated by multiple actors, always including the beneficiary	Value is generated not only by the service provider but instead with the consumer as a joint effort. Users of circular construction projects are involved in the value co-creation process. Users' participation to value creation depends on their technological skills and know-how.	**Indispensable/involved parties**
FP7. Actors cannot deliver value but can participate in the creation and offering of value propositions.	Consumers cannot execute construction project, but they can create and offer CIT in order to realize circular construction project.	Circular procurement
FP8. A service-centered view is inherently beneficiary oriented and relational.	Because consumer determines whether or not something is beneficial, all construction projects should be customer oriented and relationship based. Customers are a critical source of innovation.	The matter/reason for cooperation
FP9. All social and economic actors are resource integrators.	All service providers, of different specializations, in construction industry should work together and collaborate to learn from one another and combine resources.	Willingness to share knowledge and resources
FP10. Value is always uniquely and phenomenologically determined by the beneficiary.	Although multiple actors co-create value, it is the beneficiary who determines what that value is.	Directing role Laws and regulations
FP11. Value cocreation is coordinated through actor-generated institutions and institutional arrangements.	Institutions are the taken for granted norms and beliefs that exist in a system. These are the unspoken rules which guide our behaviors and actions in relating to the world around us.	Optimal cooperation

Interview protocol

These themes are relevant because they could pose bottlenecks or challenges for transitioning to circular economy. A standard interview can be found in Appendix A. The themes that came back in each interview were:

1. Opportunities for cooperation
2. Circular ambition/innovation subordinated by other interests
3. Characteristics/features of a certain CIT or circular policy/ambition
4. Indispensability of circular technology/ambition in supply chain
5. a. Main problem
   b. Their solution for this problem
6. Indispensability/involved parties
   a. Necessary parties
7. Circular procurement
   a. Definition of CE

b. Translation of ambitions to circular procurement
c. Criteria's for circular procurement (secondary materials/adoptable design)

8. a. Main reason for cooperation
   b. Expectation of gaining new partners
9. a. Expectation which resources needed from which party
   b. Expectation whether other parties are willing to share their resources
   c. Willingness to share resources with other parties
10. a. Directing role
    b. Laws and regulations
11. Condition for optimal cooperation

Based on these eleven themes, interview questions and interview protocol have been created.

Data collection methodology

A qualitative method was devised for this research consisting of both primary and secondary data collection activities. The secondary data was collected through desk research and helped identify the 11 themes of SDL theory. The secondary data analysis was also used to formulate the theoretical model. The interview was developed according to the 11 themes of SDL theory.

Case selection

In order to investigate these eleven themes there is chosen for the metropolitan region of Amsterdam, which is internationally a pioneer, puts a clear focus on circular economy in this region and have their circular building program. MRA also has a good overview of what they want. Despite their clear ambitions, it remains unclear how they are going to tackle their ambitions and which parties or what there is needed in order to realize more circular construction; what is going to work, what will not, remains.

The companies in which the interviews were held were divided into (a) demand, (b) supply and (c) demand and supply firms. This division of parties is made from point of view of SDL theory, where beneficiary, parties that have circular ambitions (demand) and parties with resources who are offering a certain circular innovative technologies (supply) should interact to realize more circular projects. Since there are also parties who can take both functions, there are also demanders & suppliers.

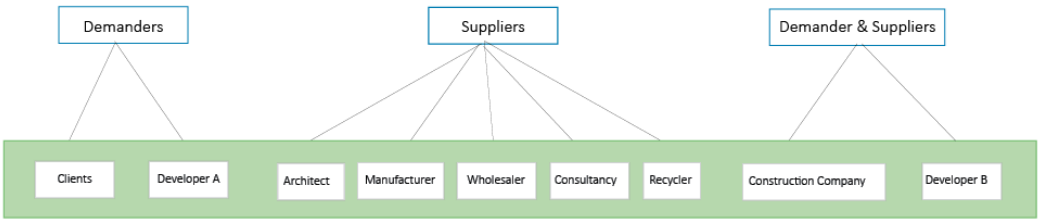

Figure 3.1: Three groups: Demanders, suppliers and demander & suppliers (own ill.)

Despite the fact that the chain partners have different roles, for example some construction companies can also develop projects themselves, they are placed in construction company category because they have been interviewed from that contractor role/expertise. The findings are also compared between these three groups, for example, are the parties on the demander side more willing to take the directing role and responsibility or vice versa.

Data sampling

The interaction between these stakeholders is expressed through snowball sampling technique where the parties traced by asking for the contact information from other members of the targeted group. In order to get an access the contact details of necessary interviewers two sampling method will be used:

- Gatekeepers: With gatekeepers implies to people/organizations that have access the contact details of the necessary interviewees. In this case the organization is going to be Bouwend Nederland.

- Snowball sampling: This method implies that respondents who can be traced by asking for contact information from other members of the targeted group. In this way the sample is getting bigger where a snowball effect will be created (Atkinson, & Flint, 2001).

Through these data sampling the supply chain parties are selected based on the products and services they are offering regarding the circular economy in the Amsterdam metropolitan area. In order to get a clear picture of the supply chain various parties are interviewed, covering de the entire construction chain: clients, architects, consultants, contractors, manufactures, real estate developers, building materials wholesale and recyclers. Appendix B contains a list of parties who were interviewed. For each category at least 1 party is interviewed. These parties are referred to anonymously, for example, construction company A and construction company B, for confidentiality.

An overview of these targeted groups in MRA is provided by TNO (2016). These group of parties include clients, consultancies, architects and engineers, real estate developers, construction companies, suppliers of building materials, wholesaler of

building materials and recycling companies who are operating in the construction sector in the metropolitan area of Amsterdam.

The primary data collection instrument was an interview which was administered to the respondents in a semi-structured interview.
In figure 3.2 an overview of involved supply chain parties is given which are interested or already are part of supply chain of the metropolitan region of Amsterdam. In order to execute the interviews the figure shown below is used to select the involved parties.

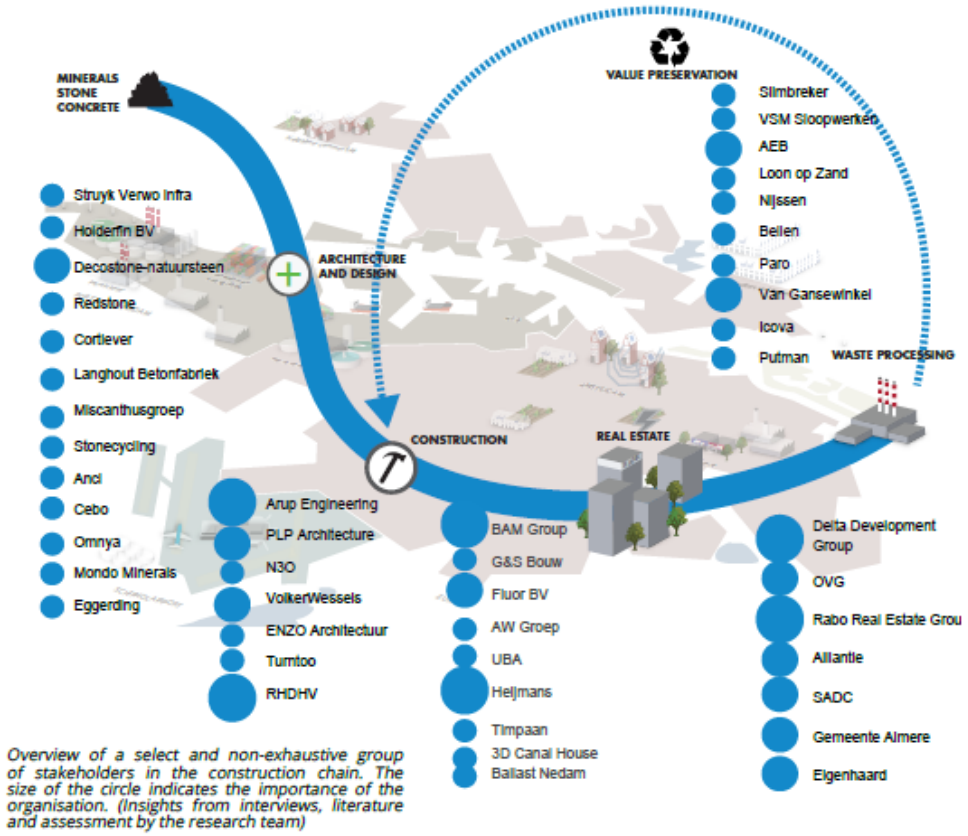

Figure 3.2: Involved parties in MRA Circular Amsterdam (TNO, 2016)

Data collection process and analysis

After conducting the interviews, these interviews will be analysed. The answers of the respondents will be analysed through aforementioned eleven themes. These answers will be compared across each supply chain parties and also between the supply and demand party. After this the main findings that are emerged will discussed. In this research, the demander firms are identified as clients and a developer. Suppliers in the

construction industry are the organizations such as architects, producers of building materials, wholesalers, demolishers/recyclers and consultants. Demanders and Supplier are the constructions companies and one of the developers.

Primary Data Collection Process - The qualitative process recommends the use of language to understand the phenomenon being studied, rather than numbers. Through use of language it will be also possible to uncover feelings and inner thoughts of respondents. Accordingly, the semi-structured interview was used for primary data collection. The primary data was collected using the tool of semi – structured interviews. According to Collis and Hussey (2009), the semi-structured interview is the most commonly used tool for data collection in qualitative research. In this research, the researcher scheduled an interview with each respondent, met up with them individually and administered a schedule of interview questions to them. This was done in their respective offices. During the interview, the respondents were allowed to clarify any doubts he / she may have whilst answering.

Clarifying the questions enabled the researcher to ensure that the meaning of the various terms in the interview schedule are uniformly understood by all the respondents. It also enabled the researcher to ask any more questions or seek some additional information that could give more insights into requirements on the views of the respondents on circular economy adoption in the construction sector. The researcher made notes as the interview proceeded. In this method, there is sufficient flexibility to allow additional information to be captured and at the same time was structured enough not to waste time.

Data Analysis Method - The thematic analytic method was used to analyze primary data collected from various stakeholders. Thematic analysis (Bazeley, 2009) is the most common form of analysing primary data in qualitative studies. The underlying principle of thematic analysis is to identify recurring themes emerging from the data, coding these themes and then interpreting them with regard to secondary data. Figure 3.3 indicates the various steps that were used to analyze the qualitative primary data collected from the semi-structured analysis in this research.

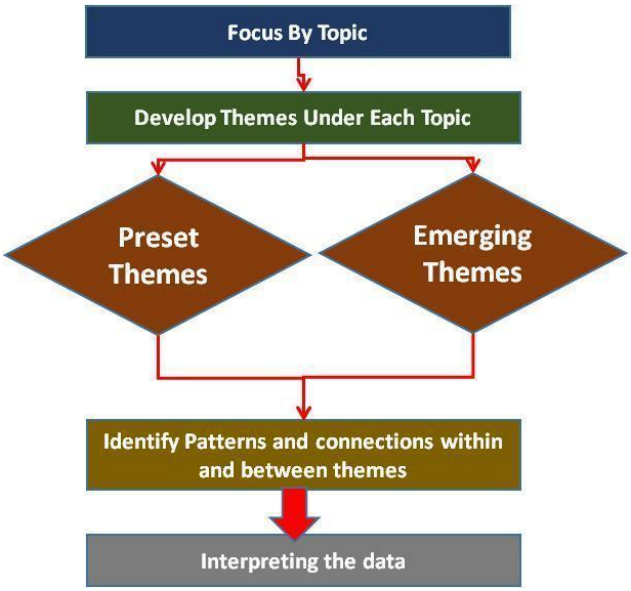

Figure 3.3. Thematic Data Analysis Process (own ill.)

Focus by Topic

The first step in the data analysis process was to examine how each respondent answered question corresponding to each topic. The topics in this research were the 11 FP's from SDL theory. The data from the different transcripts was re-organized such that the responses for each question from each respondent were collated one below the other. This was used to identify similarities or differences contained in the data for each topic. In addition, through this method it was possible to identify similarities or differences of opinion cited by the three categories of demanders, suppliers & demanders and suppliers for each of the FP's.

Developing Themes under each Topic

A process of identification of themes was used to analyze the qualitative data collected through the semi-structured interview. The text was analyzed first to identify themes already derived from the secondary data analysis and summarized in the conceptual review. Each of these themes was given an abbreviation to help organize them. The data was again analyzed to identify any new main themes or new sub-themes relating each FP. Each of these themes were accorded abbreviations for analyzing and categorization into emergent themes. This entire process was iterative and involved multiple readings of the primary data to identify all possible themes from the data.

Identification of Relationships Between Themes

After the main themes and the sub-themes were identified, the researcher again analyzed the data to identify patterns or relationships between the themes. The similarities and differences under each theme corresponding to each FP. The key ideas expressed by the respondents were compared with the secondary data to identify

recurrent themes emerging from the data. Which themes consistently emerged throughout the data were identified to indicate their relative importance.

Interpreting the data

Once the key themes and the relationships between them were identified, the researcher used a process of narrative analysis to interpret the data. This includes supporting key inferences regarding requirements emerging from the data with quotes given by the respondents. These inferences were compared and contrasted with secondary data on benefits of CE for each stakeholder in the construction sector and the associated challenges. This interpretation led to developing recommendations on what needs to be done by each stakeholder to facilitate the transition of a linear construction industry to a circular one.

CHAPTER 4. RESULTS AND DISCUSSION

This section will explore the kind of services and conditions under each of the SDL FP that have been indicated by each of the stakeholders in this research to promote CE in the construction sector. The database for the findings in this section is given in Appendix C. In this section the findings through three categories of demanders, suppliers & demanders and suppliers for each of the FP's will be explained.

4.1. RESULTS

FP1: Opportunities for Co-Operation – the generation of new ideas that will promote CE adoption is contingent on securing co-operation from multiple stakeholders in the construction sector. The demanders indicate that greater cooperation is required among municipal authorities and civil engineers. This suggests that for the clients, it is

the government which has the main responsibility for facilitating CE. In addition, demanders state that there must be quantitative metrics/indicators for monitoring the effectiveness of a CE initiative. For the demanders & suppliers, new product development related to CE and maximizing material use depends on co-operation with chain partners and creating mass awareness in the construction sector about CE and its benefits. This view is corroborated by the suppliers who also state that there is the need to create a 'mass movement' towards making the adoption of CE principles mandatory in the construction sector.

For example, one of the construction companies (construction company C) sees opportunities for cooperation in investing in Circular Building platform. This because the financiers offer the construction company an interesting funding and make a deal that the materials of a project, where they work together, the construction company gives a certain residual value after the materials of this project will be released. At the time the tenant will no longer use this building, the construction company and the financier will jointly look for a new project where they give these materials a new life. This cooperation advantages the construction company in two ways: (a) they get an interesting financing and (b) they already make an appointment in advance where they work together for a new project.

An interesting instrument, according to a consultancy companies is innovative tendering: a partnership instrument whereby a number of parties come together and then they will jointly create an innovative project. Because of the fact that it is a new method and the engineering department of a municipality do not know whether it works, they want to practice this method with a small project. However, there are still lots of meetings and lots of consultations needed for such a small project, it does not allow them to create such a intensive project.

In addition, the governmental parties prefer to keeping the collaboration as low profile as possible, without any cooperation agreement. So if somebody is going to step out by tomorrow, it is possible.

In addition, what *developers* do, to promote circularity and collaboration, is that they work with the suppliers by making an analysis of the building in order to see what is in there that they can re-use and by getting in touch with suppliers who might be able to use these materials in the building, to dismantle these materials before the demolisher starts to their work.

Despite of the fact that the recyclers do not execute construction projects themselves, unless it emerges from the collaboration that they also will be building together, which is not the case yet, they see the opportunities for cooperation in processing the materials, making materials available for applying in circular innovative technologies.

These findings indicate that CE development in the construction sector is a collaborative effort with multiple stakeholders coming together to develop circular projects. Without co-operation amongst all the stakeholders, it will be difficult for the

construction sector in the MRA to transition to a CE. For example, a CE based tendering system will need to be accepted by the construction company who places the tender and who mandates that only recycled materials will be used, by the suppliers who can supply high quality recycled materials and by architects who know how to use such materials into their construction design.

FP2: Circular Innovation Subordinate to Other Interests – Even though circular economy is a very hot topic nowadays, there are other activities on top of the agenda, such as acceleration of construction (NL: versnellingsopgave bouw), because there has to be many houses built in the Amsterdam metropolitan area. There are two completely different civil servants: one who works in an entirely different department of the municipality (sustainability) compared to the civil servants who are working with, for example, acceleration of construction. Those civil servants have different interest, different urgency, such as building as much as possible houses in a short time. They are not concerned with sustainability, they do not take circular building principles into consideration.

Also the manufacturers state that they want to apply circular products in projects, for example, frames that are released from a demolition project, but they run into the fact that those frames are often 20-30 years old and no longer fully meet the requirements (for example, isolation requirements). In this case these products must be tested again which makes it even more expensive. Plus there are only very selective clients that are really interested in recycled window frames. Because the rest of customers, just want the brand new product.

Almost all of the interviewed parties think that finance/money is the most important factor in order to make a transition. However according to construction company B, it does not always have to expensive to realize a circular project, for example Alliander building. However projects that are progressively circular have an ample budget, because the process is different and the risks are unknown.

Incorporating CE will depend on how much priority is given to it by stakeholders. According to demanders, CE projects are hampered by pressures of time and cost overruns and by reluctance of clients to pay higher prices for CE constructions. Demander & Supplier firms also face the obstacle of higher costs, pressure from clients to finish CE projects in time and restricting of existing plans to accommodate CE. Even suppliers are primarily constrained by time and money involved in getting CE practices incorporated into their operations.

These findings suggest that there is a high level of ignorance prevailing in the Dutch construction sector on CE and education is required to show all stakeholders that CE does not necessarily lead to higher cost of construction and longer time to market.

FP3: Characteristic Features of CIT Projects / Policies – The demanders cited the Amsterdam Circular Urban Innovation Program, Action Agenda CE, GWW and the Service as a Product Model as being relevant to them. An analysis of these CE initiatives indicate that clients are primarily motivated by concerns of functionality and performance of CE buildings. They want to trade off higher costs of purchase in relation to superior benefits provided by a CE building as compared to a non – CE building. This includes greater comfort, better quality of life and lesser pollution levels. The 'product' in other words must provide more 'services' that will secure the well-being and comfort of the users.

Some of the CIT initiatives cited by demanders & suppliers include Heijmans Removable House, Alliander building in Duiven, the ABN Amro Circl pavilion, and the Co-Green Stadstuin Overtoom. These buildings are characterized by their low input costs, their lower cost of operation, their innovativeness and the large amounts of publicity and press they have received. It is evident that for the demanders & suppliers such as construction firms, cost of construction, higher profitability and enhanced customer goodwill are the main motivations for adopting CE.

The suppliers cited the Circular Viaduct, CE policy and recycling processes as being important CE initiatives. This suggests that for suppliers, it is provisioning of adequate CE infrastructure, identification of sources of high quality recycled material and recycling manufacturing processes that will increase the likelihood that they will adopt CE.

Different interviewed parties apply different circular innovative technology and approaches to promote circular economy. Whereas the developers choose for service-as-product model, executive architect companies and contractors are choosing for design for disassembly, designs that can fit in any location. An important side note here is that the interviewed parties are selected on the criterion that they have products, services and policies on the area of circular economy. This allows them to distinguish themselves from other companies in the Amsterdam region; in that sense they are front runners in the field of circular economy.

As an example, construction company B states that the question from the clients was that the building had to be 80% circular. They have drawn up a certain definition of it themselves, in which they said "we find this circular".
The building had to be renewed. Part of the building had to be demolished because of old condition. 10% of demolition part went into incineration or collapsed and the rest replaced with reusable or circular materials, such as concrete with granulate and steel.
This project has considered circular principles at the design stage itself. This is according to:
- Reuse existing built environment;
- Maximum re-use of existing buildings (83% of the existing building has been kept);
- Reuse of existing construction, existing steel is reused;

- Buildings have been stripped of existing facades so that the foundation did not have to be adapted;
- All demolition concrete has been used as gravel substitute in new concrete;
- Steel constructions have been minimized in its weight with the help of roller coaster builders, thus avoiding unnecessary use of raw materials;
- Existing bitumen roofs have been returned to the bitumen plant and recycled in the chain;
- Waste has been recycled for more than 90% during construction;
- Facade of the interior walls is made of waste wood that would have gone in the incinerator;
- Reuse of existing toilets;
- Reuse of existing ceiling plates;

This building is considered 80% circular, because the building consists of at least 80% circular of raw materials. However the question remains to what extent can keeping the part(s) of building as it is, can be considered as circular? This will be further discussed in Chapter 5.1.1.

There are also companies that do not wait till the client is going to ask for a circular project. So is, for example, the Circular Viaduct project created.

Figure 4.1: Viaduct with LEGO concept

This Circular Viaduct is designed according to LEGO principle. When building with LEGO, it can be taken apart and build something completely different somewhere else, without wasting any material. Even the foundation of a circular viaduct will be easily removed when it is demolished. And the beams on the pillars are linked so that they also can be disassembled. Every element from the viaduct can be dismantled without any waste and used somewhere else.

Whether it will be an auxiliary bridge, a bicycle bridge or a a provincial viaduct bridge depends entirely on the potential locations and the opportunities the consortium will get to build.

Not only contractors, also some of the suppliers are committed to circular economy. They use recycled raw materials and supply reusable products; reused materials are used in production of reusable products, such as hollow-core slab floor.

Figure 4.2: Circular hollow-core slab floor

This hollow-core slab floor can be reused in its entirety in any other construction. Despite of this innovative product, there is no demand for this product because of the extra costs.

Companies state that it would be nice if successful examples were also developed in MRA and that a lot of publicity should be given to these projects, so that more awareness would be created. A lot in still unclear, there are many barriers but there are also circular projects realized.

FP4: Indispensability of circular technology/ambition in supply chain – The demanders indicate that current GWW initiative by the Dutch Government is the only tangible evidence of CE in the country. For demanders – like clients or purchasers of buildings – it is necessary to be provided with metrics with which they can measure and compare performance of CE compliant buildings with CE non-compliant structures. No other technologies were mentioned by the demanders & suppliers and by the suppliers indicating the relative lack of CE infrastructure and technology in the MRA. However, the primary data indicates that for the demanders and suppliers and for suppliers, it is important for any CE initiative or technology to be commercially viable and value adding. If there is no added value from CE initiatives, it will not be adopted in the construction sector.

What matters is commercial added value for the company to participate in CE. If a company does not see any commercial added value because its innovation, then a company is not willing to bring this circular innovative technology at a higher level than just doing a pilot study. So the suppliers of the hollow slab floor have a unique position in the supply chain. Despite of uniqueness of this product and the service this company offers there is no demand for this product because of the extra expenses.

This shows that agreements on paper is not enough motivation for the companies to commit to CE. The arrangements can be made, but if it does not ultimately yield money, the company does not go through with it. There must be some extra benefits to be gained for a company.

FP5: Main problems with CE – Demanders indicate that there are no quantitative metrics or measuring instruments to measure CE effectiveness, no legal framework for CE implementation, lack of awareness about CE and the differences between CE and sustainability. The demanders & suppliers also cite similar obstacles. In addition, they indicate that construction firms are cautious about adopting CE because of fears of cost and time overruns and the threats associated with implementing a new concept, lack of knowledge and concepts that can be practically applied in buildings. The suppliers indicate that often their clients do not demand recycling materials. Fresh primary raw materials are cheap and abundant and suppliers do not see advantage of using recycled materials. In addition, they cite that compliance with multiple policies of different municipal authorities on matters related to CE is too complex a process for them to adopt CE principles more wholeheartedly.

It is striking to see that clients, architects and construction companies experience lack of measuring tools or steering indicators for circular economy as one of the biggest problems. A major obstacle to an acceleration of circular construction is, according to construction companies and manufacturers, a lack of demand from the clients. Companies indicate that they are willing to meet the challenges that circular construction entails when clients ask for it. But at the moment, that question is insufficient. In addition, it is important for the awareness of clients: the demand for circular construction can only arise when it is clear what exactly it means and what it aspires to.

In addition, manufacturers and contractors think that the awareness is one the reasons that can hinder the transition to CE. That is because the most people do not realize that they can make a difference. For many people the benefits of circular economy, the "what's in it for me" is not clear. Contractor B states that for the clients it must be clear why they want a circular project, otherwise they will not ask it either.

The concept of circular construction is defined by various parties, such as national government (RVO, 2016), MVO Nederland (MVO Nederland, 2015), Ellen MacArthur Foundation (Ellen MacArthur Foundation, 2012(and Circle Economy (Amsterdam Circular, 2015). Although some elements correspond from these descriptions, it lacks specifications.

However the question remains: what the potential supply chain of the Amsterdam metropolitan area think by the concept of circular construction? To simulate circular economy it is important that all the chain partners are on the same page. An unambiguous definition could be the dot on the horizon where the companies can base their circular ambitions and circular products.

The interviews with the regional governmental companies show that there is no ambiguity about the concept. This also applies to executive companies, but an overall picture of the concept of circular construction is missing.

It is striking to see that some companies have the idea that they are working with circular principles while, in particular, they are doing energy saving measures and reducing or separating waste streams, such as reducing transport movements or placing different waste containers on the construction site.

The circular economy related principles that matter the most mentioned by companies, can be found in table below. Sometimes companies do not know the possible interpretation of circular construction.

Elements mentioned by companies in circular construction
Recycling of materials as much as possible
Using materials as efficiently as possible
Everything remains in its value
Using materials with the least possible environmental impact
Closing the loop
Lifetime extension
Reduce Waste
Minimal material use

Circular building is also associated with cradle-to-cradle, energy-efficient buildings and the recycling of materials. Also creating value and value preservation is associated with circular economy.

Ambiguity of the concept is important to prevent the concept from losing its value and becoming a container concept.

Several critical remarks are made by various companies on the circular construction concept. According to a construction company A circular construction is a new term for services and products that have been offered for much longer.

A number of companies propose to set stricter requirements regarding the reuse of construction materials. The change in the environmental performance of buildings (NL:EPG waarde, milieuprestatie), will contribute to this. By giving the materials a limit value, that the materials has to meet a certain value can encourage the companies to do more circular construction projects.

High-quality reuse of materials is still in the experimental phase. This means that many questions remain, for example regarding the quality of materials, labor costs and time requirements. Sharp planning in the realization process of construction projects is essential. However, it also takes more time and money to disassemble. It is also important for the demolition contractor that he knows his market for the disassembled materials prior to a project, because the costs go up when he has to store it in the meantime. Producer A sees solution in levying taxes on primary

materials.

FP6: Indispensable Parties – All the three stakeholders cited different stakeholders as being most important for a CE. These include construction firms, demolishers, developers, consultants, government authorities, funding agents like investors & banks, willing to fund CE building projects and suppliers of high quality second hand materials.

FP7: Circular Procurement - The demanders stated that circular procurement can be enabled through the initial stages of construction itself – which is to design the buildings such that they are easily demountable. This will enable the production of high quality secondary raw materials whenever the building is demolished. These materials then become inputs for fresh constructions. According to the demanders & suppliers, procurement of CE materials will depend on both the price and quality of materials. Construction firms wish to pay lesser amounts than they would for fresh raw materials for high quality secondary construction materials. For the suppliers, the main concern related to circular procurement is identification of sources of secondary materials that are produced without negatively impacting the environment. The materials must be of high quality, last as long as possible and be adaptable for use in new constructions. Most of parties prefer procurement based on ECI (NL: MKI). However the MKI measurement of projects is based on the first life cycle (LCA) instead of multiple life cycles. Circular projects, especially viaducts, will have higher ECI at the first life cycle because it should be more robust, there will be more materials used. These MKI values decreases in second, third etc. life time. Therefore, Client E is working on a MLCA tool to make circular projects more feasible by taking multiple lifecycles into account.

Almost every company state that construction projects are being tendered on the basis of lowest price. Clients choose for the cheapest option and want to avoid risks at the same time. A contractor also wants to avoid risks, because he is liable for the work he delivers and must be able to offer guarantees to the parties. It is difficult for a contractor to, for example, offer guarantees on secondary materials of construction materials, because he is not sure about the quality of these materials.

Companies indicate that they would like to see clients ask for the best solution instead of the lowest price.

Architects with executive construction function suggest that the clients should give more freedom to the companies who will offer circular product or project, where the companies give an indication how it will be different in time and money. So indicate a fixed price for a project is not possible within the circular economy. Because circular economy is by definition innovation and innovation is new, there are also many risks involved. Therefore there should be space and freedom for innovation in order to say "to realize this project it's going to take us half a year longer" for example.

What they want to be changed is that client should ask for added value a company will

create if they are going to offer a circular product. Even though there is not a sufficient question from the clients, there are some companies who take action from their own initiative.

Construction company A prefers DBFM contract when comes to circular procurement, because they want to be involved from beginning of the project, for example the project what they did in Soest: National Military Museum.
That is a project where the construction company A maintains that location for 30 years. Also they did the design, the construction, management and maintenance of the building. This means that as soon as a project pays back on energy within 30 years pays, it gets interesting for the party and they want to do it right away. Because parties know that they are attached to this project for 30 years.

Side note to this statement is to what extent energy generation or saving can be related to the circular economy. But the main message of this state is the willingness of companies to be committed to the project from the beginning and for a long time where they can provide maintenance.

FP8: Reason for Cooperation – According to the demanders, CE projects are inherently beneficial because they enhance the social importance of the city/ neighborhood in which they live. For the demanders & suppliers, CE projects are beneficial not only because of social prestige but because they promote cost savings, add value, enhance customer satisfaction, achieve environmental conservation and provide new job opportunities. In addition, CE implementation will fulfill the ambition of Amsterdam to become the CE capital/frontrunner of the world. For suppliers, CE is important because it contributes new knowledge, technologies and ideas related to cheap, high quality procurement and help identify sources of cheap but high quality raw material which they can supply to the construction industry.

Companies feel responsible for societal benefits and they consider this as an investment for the future. They want to contribute to a better environment for future generations.

Also creating financial added value could be the motivation for most companies to focus on circular construction. Many supply chain companies state that too much is thrown away and that it can be handled in a smarter way. The majority, however, is driven by motivation, involving social costs and benefits (total cost of ownership). One of the most important reasons to shift our economy to CE is from a social perspective: reducing CO2 emissions. Companies feel responsible for social costs and benefits and they regard this as an investment in the future. A large part the companies are therefore prepared to contribute to a better environment for future generations.

FP9: Resources Required – According to the demanders, the most important resources required for CE implementation are government policies that promote CE. This can take the form of mandatory use of recycled materials in new constructions and

providing tax incentives to builders and suppliers of high quality, recyclable materials. Other resources included making recyclable materials cheaper than primary raw materials and knowledge dissemination about CE and its benefits. The demanders & suppliers consider knowledge about CE to be a vital resource, education and skill upgradation, development of best practices related to CE and the use of new technologies such as BIM in construction projects. For the suppliers, the most important resources to implement CE are laws and regulations, limits on greenhouse gas emissions from buildings that will force them to implement CE, leveraging the knowledge of CE experts from other countries, developing those technologies that facilitate recycling of high quality secondary materials and business / revenue models that lower the cost of secondary raw materials.

Almost all of the interviewed parties state that they are willing to share their knowledge, experience and expertise with other parties. Also construction company A states that they doing nothing but sharing knowledge with other parties every day. However according to architect B, in order to share knowledge, parties have to be involved in the project:

FP10: Directing Role – The views of the respondents indicate that all stakeholders in the construction industry will benefit from a CE. However, the stakeholders who will most benefit are the construction companies and the clients. This is because of lower input costs of construction that make projects more profitable for the construction industry. The clients will benefit from lower operational costs of the building and a healthy living environment.

FP11: Conditions for Optimal Co-operation – According to the demanders, openness and transparency amongst all the stakeholders will facilitate more co-operation amongst themselves. Those parties that have successfully implemented CE must share about their experiences so that other agents will also get encouraged to adopt CE. The demanders & suppliers also cited the same conditions but also indicated that it was necessary for all stakeholders to be involved early in the project, agree on common objectives, link project objectives to quantifiable results and facilitate process of constant communication with each other. For the suppliers, profit / incentive sharing would be powerful tool to secure mutual co-operation. They recommend risk taking amongst the different stakeholders, taking initiative, putting in place education and training processes as well as greater interface between the design and project implementation departments.

Construction company B indicates that there is a lack of clear and appealing examples of circular construction projects. In order to make a transition to circular construction there is a need for success stories. At present there are no example projects that simultaneously provide insight into the effects of a circular approach on business case, cost, organization and planning. There is a need for a total concept, for which clients,

corporations and municipalities as well as the construction sector can learn from. The success stories do exist, but they should be better communicated. For example, a number of companies have experimented with circular construction. These experiments show that they have saved costs through high-quality reuse, as a result purchase costs for the construction were lower.

4.2. Analysis and Discussion

This section analyses the key opportunities and obstacles for demander, supplier and demander & supplier firms in transitioning to a CE. Figure 4.2 shows the distribution of the three categories of stakeholders.

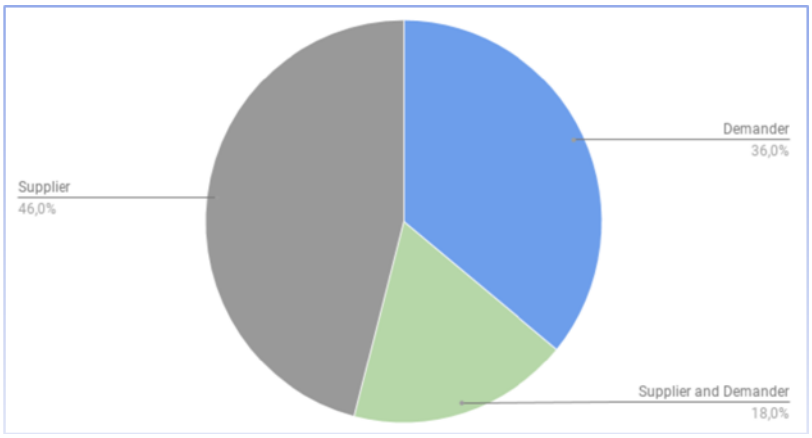

Figure 4.3.1. Distribution of Stakeholders

From figure 4.3.1 it is observed that while demander at 36% and supplier and demander firms at 18% are distributed, there are more supplier firms at 46%. This suggests that this research will provide insights on CE more from the perspective of procurements and how this contributes to a CE. There are the sub-themes developed out of the qualitative analyses. These sub-themes are developed by different respondents saying the same thing in different ways.

Demander Opportunities – Demanders are those that trigger the need for construction projects. In this research, the demander firms are identified as clients and a developer. Figure 4.3.2 indicates the key opportunities highlighted by the demanders.

Sub-Themes	Remarks
Less Dependence on external raw material sources	- "The indicators we now apply for our procurement are adoptive building and demountable design and the use of secondary materials." (Client A) - "In fact, there should be stated in the demolition and tendering process that the demolition material should be used for the construction of the building that will be realized in that place." (Client B)
Preservation of the environment	- "We are now looking for technologies, such as concrete crusher where more sustainable concrete can be made. Also we are trying to define a number of projects where we can apply CO2 instead of generating CO2 emissions." (Client B)
Contributing to resource conservation	- "High-quality reuse of raw materials must become a new standard, that to realize a project it does not necessarily have to be new materials, but that the raw materials should be reused, otherwise the raw materials will be depleted" (Client C) - "We want to avoid using as much material as possible and if we use them, we use them in such a way that it can be reused."(Client D)
Better Brand Value	- "We want to move forward, we to be a leader in the field of CE" (Client A)

Figure 4.3.2. Opportunities from CE – Demanders

From figure 4.3.2 it is observed that all the demanders have indicated that a transition to a CE will lead to less dependence of the construction sector on new raw material procurements. Also the demanders have indicated, this will lead to fewer emissions for operating the building and help them make a contribution to preservation of the environment. This corroborates the view of Lacy, & Rutqvist (2016) who observed that CE results in less waste generation, fewer emissions of greenhouse gases and less pollution.

Demander Obstacles - Figure 4.3.3 indicates the key obstacles demanders have cited to a more proliferated adoption of CE in the MRA.

Sub-Themes	Remarks
Administrative Pressure	- "There is less time now, but CE takes more time. They way we deal with CE now is too hastily." (Client C) - "The pressure on the housing in the MRA is very high due to economic growth and the increasing of population. So the whole process of how to design a circular house takes a lot more time." (Client D)
Higher Initial Costs	- "What you often see with the circularity is that the costs arise before all the benefits, where you often have to invest first and earn that back later. As a government you might have to borrow more money from the bank. That means that you are going to make more debts initially."(Client D)
Ignorance/Apprehension	- "What is circularity actually? How do you do that? What is really needed? There is so much that we do not know yet."(Client E)
Poor Input Qualities	- "At the moment we only have qualitative objectives because circularity cannot be measured yet. There are no relevant steering indicators available." (Client A)
Internal Conflict	- "You also see that everyone is busy. It is a new topic and not always much space in those organizations. So it's also about how you can arrange that with each other. " (Client B) - "People are in such a hurry with this theme. You have to take the parties within your organization on board too. "(Client C) - "Two groups of people within municipalities who sometimes do not know each other: 1. Working on accelerated construction 2.Innovation and sustainability ." (Consultancy A)

Figure 4.3.3. Obstacles for Adoption of CE – Demanders

From figure 4.3.3 it can be seen that administrative pressure is the main reason for non – adoption of CE by the demanders. Geraedts et al., (2015) observed that construction firms are under pressure from clients who want the projects completed as quickly as possible and from government authorities who push from faster constructions in order to counter the growing demand for housing and commercial space. In such a scenario, it becomes difficult to devote time and resources incorporating CE principles into building plans. Figure 4.3.3 also shows that ignorance amongst demanders is a critical obstacle for adopting CE. For most demanders it is not clear what the benefits of CE are or what CE is about. They fear higher costs of a CE compliant building while hesitating to use recycled materials due to concerns about quality. Internal conflict among government departments between those authorities

who want to push for CE and those who are busy with other targets, such as acceleration of housing, is another obstacle for the greater adoption of CE in the MRA.

Supplier Opportunities – Figure 4.3.4 indicates the opportunities presented by CE to suppliers in the construction ecosystem such as architects, construction companies, recyclers, manufacturers and wholesaler of building materials and consultants.

Sub-Themes	Remarks
Better Brand Value	- "The main reason to join the circular cooperation is that in 2025 we want to be the most sustainable civil builder in the Netherlands. We want to be the leader and we want to be distinctive, making our own employees happy by giving them the challenge to make the world better." (Architect A) - "We want to be the most sustainable company in the Netherlands by 2025." (Architect B)
Tax Incentives	- " Every person always wants the cheapest option. It must be incorporated in the procurement, we must first accept that it is a few years it is going to be more expensive than raw/virgin materials, but this can be arranged by levying the taxing on this materials." (Manufacturer of building materials A)
Lower costs of primary resources	- "Secondary materials cost more than the primary resources, processing of secondary materials costs more. Secondary materials now disappear for the lowest price option, such as the underground for construction sector, and probably also driven out of the city. " (Recycler B)
Ready Made Source of Input Materials	- "It has to monitored that resources go to those companies that recycle high quality. " (Recycler A) - "Make more secondary materials available. " (Producent of building materials A) - "The materials must find their way to us. " (Recycler B)

Figure 4.3.4. Opportunities for Adoption of CE – Suppliers

From figure 4.3.4 it is observed that all the suppliers feel that adopting CE principles will enhance the brand value and customer goodwill. Huysman (2017) explains this by saying that in a market environment where demanders are environmentally conscious, suppliers that follows CE practices that preserve the environment and help resource conservation will be preferred over those who do not. Suppliers will be able to avail of tax incentives given by the Dutch Government to parties who promote sustainable

construction practices thereby lowering input costs. The suppliers also indicate that CE will provide them access to ready-made input sources which will have the impact of driving down input costs. Rust (1998) made a similar point by saying that the concepts of reuse and recycle ensures that waste generated by building demolitions forms the input for new buildings. This means that suppliers in the MRA do not have to procure materials from outside the country from their traditional procurement sources as well. Reduced input costs of secondary materials has the effect of improving supplier profitability on the one hand and reducing overall costs of construction on the other.

Supplier Obstacles – Figure 4.3.5 indicates the key challenges that prevent suppliers from adopting CE.

Sub-Themes	Remarks
CE Concept New	- "I think that Circular Economy is not a goal in itself. Parties still do not know enough about it and which goals they want to achieve with it."(Consultancy B)
Lack of Monitoring	- "One of the pillars in tendering was provable sustainable use of materials. We advise and encourage the manufacturers to make LCA and submit them to the national environmental database so that their products are visible in that database. Preferably not as industry average but on their own brand specific products to prove the percentage of sustainable material or product. "(Wholesaler of building materials A)
Lack of Regulation	- "We have designed facade elements that you can exchange, or place in another building. However especially within the construction industry you have to deal with changing rules continuously. So steel, which is good today, has sufficient strength, these requirements may become not sufficient enough within 10 years. This also to glass: shifting from single glass to double and triple glazing. " (Architect A)
Poor Networking	- "Coordinating at a large level with several parties with different circular policies is difficult. Even alignment alone within 1 municipality is difficult enough, let alone all the parties within the MRA."(Consultancy A)
Infrastructure for CE not yet in place	- " Usually the materials from the buildings are applied under the road, low quality recycled, while you can use it in a new product, high quality."(Recycler B)
Higher costs of leveraging new technology	- " It costs a lot of money to clean secondary materials streams to sell them to manufacturers of circular products, but virgin materials are now our biggest competition that we try to replace and the intention is that it should cost at least the same as the virgin materials or even cheaper." (Recycler A) - "There is no demand for our circular products, because our clients have to pay extra for it."(Manufacturer A)

Figure 4.3.5. Obstacles for Adoption of CE – Suppliers

From figure 4.3.5 it is observed that all the suppliers feel that CE is a new concept and still not very well developed. This prevents them from using CE more in their projects. There are few standards related to quality of recycled materials, with fewer monitoring mechanisms that ensure quality. This makes procurement agents reluctant to use recycled materials as fresh inputs for their demander clients. Schoolderman et al., (2014) observed that the world's supplies of raw materials like fuel, water, stone, sand, iron, cement etc are still abundant and this makes procurement agents hesitate to use recycled materials into building projects. All the suppliers indicate that there is a lack of co-operation and co-ordination amongst the various stakeholders in construction projects that make it difficult to adopt CE in a cohesive manner in any project. Also the infrastructure for demolishing buildings in an appropriate manner, collecting and reprocessing such waste is still not present in a manner that that promotes the more proliferated adoption of CE by suppliers.

Demander & Suppliers Opportunities: Figure 4.3.6 shows the opportunities for construction firms that are the demander & suppliers in the construction sector.

Demanders & Suppliers Obstacles: Figure 4.3.7 shows the obstacles for construction firms that are the demander & suppliers in the construction sector.

Sub-Themes	Remarks
Zero Waste Generation	- "We are looking for ways of re-using the secondary materials in a smart way so that we can meet different climate objectives and consume less raw materials." (Developer B)
Demand for CE with clear indicators	- " The question must be asked correctly so that it can be answered sustainably by the market." (Construction Company C)
Greater Brand Value	- "When we as a company can take the ambitions of the clients in the consideration and by anticipating to this ambitions by introducing circular concepts, can make us distinctive." (Construction Company B)
Opportunities as facilitators of CE	- " As a company we have the position in the supply chain that we can bring the companies together: the client, at the front of the supply chain, with the executive companies, at the back of the supply chain, by creating a certain circular building concept. " (Construction Company A)
Lower Input Costs of Construction	- "The first initiator goes for the lowest price, who only has interest in making investments as low as possible in a short term and then selling it for as much money as possible."(Construction Company C)
Employment Generation	- “We often work in the more difficult parts of the city. It is better to not just create a better areas, but also create employment opportunities. I think it is also part of circularity. “ (Developer B)
New Technology Development	- “In new construction concepts we work together with the supply chain and we also jointly develop new products for the market.”(Construction Company A) - “At the moment is is only interesting for us if the interests of the supply chain for demountable building is increasing. “(Construction Company B)

Figure 4.3.6. Opportunities for Adoption of CE – Demander & Supplier

From figure 4.3.6, it is observed that as the construction sector as a demander will benefit from lesser consumption of raw materials and natural resources through CE. In addition, CE will result in zero waste generation. This is a significant benefit given the finding by Wilkinson and Remoy (2011) that the construction sector has historically been one of the largest consumers of raw materials and a significant contributor of waste as well. As a supplier, construction firms benefit through enhanced customer goodwill and brand value generated through CE that will drive more demand for their buildings. They also have the opportunity to act as facilitators of CE amongst all other stakeholders in the construction ecosystem. Demanders & Suppliers also indicate employment generation and development of new technologies as opportunities. This corroborates the views of Lacy and Rutqvist (2016) who found that the adoption of CE is contingent on new technologies for recycle, reuse and remanufacture that will in turn provide new sources of employment in research & development, infrastructure development, training & development etc.

Sub-Themes	Remarks
Government Pressure/ Client Demand	- "Because a project can be done faster but it can also be slower and it can also be more expensive. So the client has to let it go a bit." (Construction company A) - "I think one of the reasons for applying CE is that client asks for it. If the client says it must be a circular building and then you have a playing field and you register for tender and then there is apparently value for the client. However at the moment there is not much demand from the client."(Construction company A)
Risk Perception	- "I think that for many companies the benefits of circular economy: "what's in it for me" is not clear and because they do not know the benefits they do not want to take the risk." (Construction Company B)
Lack of Knowledge	- "The clients do not know what they want to ask and we do not really know how to implement." (Construction company B)
CE- An unfamiliar Concept	- "What is 100% circular purchasing? Nobody knows. We all want to be circular, but nobody knows what circular is. Creating definitions for a physical product is something what we find difficult." (Construction Company A)
Raw Materials Abundant & Cheap	- "The fact that we build so much with raw materials means that these raw materials are easy to obtain and also cheaper. That is why we build with less secondary materials, there are simply less secondary materials." (Construction Company B)
Blame Gaming	- "65% of our building faults have to do with design, that the design is not done so well and that the architects are too busy with the aesthetic side and not so much with how actually it should be made, function and dismantle." (Construction Company C)

Figure 4.3.7. Obstacles for Adoption of CE – Demander & Supplier

From figure 4.3.7, it can be seen that demander and supplier firms face pressure from both the clients and the government for the quick completion of their construction projects. This makes it difficult for incorporating CE principles in construction projects.

Another recurring theme is the lack of awareness and the unfamiliarity associated with CE adoption in the construction sector. In addition, there is the lack of adequate CE related infrastructure that facilitate construction companies and developers from adopting CE into their projects. There are apprehensions about quality of recycled materials, the risks associated with adopting CE in construction projects and of higher costs of the project which will lessen the attractiveness of a CE project to cost conscious clients.

From the above analysis, the similarities between opportunities and obstacles for all three stakeholders are summarized in table 4.3.8.

Opportunities	Obstacles
Contributing to resource conservation	CE - An Unfamiliar Concept
Elimination of Waste	Lack of Knowledge
Contributing to environmental sustainability	Higher Initial Costs
Less Dependence on external raw material sources	Lack of Adequate CE Infrastructure
	Risk Perception
	Client Demand
	Government Pressure
	Blame Gaming

Table 4.3.8. Similarities (Opportunities & Obstacles)

Table 4.3.9 summarizes the differences in opportunities & obstacles or all three stakeholders

Opportunities	Obstacles
Ready Made Source of Input Materials	Higher costs of leveraging new technology
Circular procurement	No Standards for CE
New Technology Development	Poor Networking
Employment Generation	Lack of Regulation
Tax Incentives	Lack of Monitoring
Higher Demand for CE conscious demanders	

Table 4.3.9. Differences (Opportunities & Obstacles)

According to the most of the interviews parties there is a lack of demand for circular construction projects from clients side. However, since there is no commonly acceptable definition for circular economy, clients do not ask for circular economy elements in their construction projects. Construction companies do not mind giving their own interpretation, but the question remains whether if this interpretation is (always) good and corresponds to the client's demand. Construction companies do not know at that moment whether they execute the demand of the client in a right way and how their competitors are tackling this demand.

Circular economy requires long-term thinking, while it is very uncertain what the requirements for certain materials will be in the future. The materials are getting

better, such as better isolation value, longer life and lower prices, making it uncertain whether materials from existing buildings are still desirable in the future and meet the building requirements. And to meet the requirements these materials have to be processed which can make these materials more expensive than virgin and/or modern materials. As long as these materials are cheaper than secondary materials the preference will be for virgin materials. This can be counteracted by levying taxes on primary materials or making subsidy available on secondary materials. However it is only possible when there is enough secondary materials are available.

In addition, the safeguarding of quality of the reused materials can be difficult because the right quality certificates or information about this construction products are missing. There is therefore a need for new legislation and regulations.

Based on these similarities and differences the following main findings are emerged for a possible acceleration of circular construction projects: (1) clear definition of circular economy with quantitative circular indicators, (2) circular procurement, demanding a minimum score for circularity, (3) making more secondary materials available by consistent rules and regulations and (4) directing role. These findings will be further discussed in the next chapter.

5.1 MAIN FINDINGS

In this chapter contains the main findings and opportunities for these findings. Also the meaning of these main findings to practice and science will be discussed in this chapter.

5.1.1 CLEAR DEFINITION OF CE

There is a need for unambiguous of the concept of circular economy. First of all, it is crucial for the governmental organizations to work efficiently with CE. Also the awareness of potential clients is important: the demand side for circular construction can only arise when it is clear what exactly it means and what it aspires to. Finally, concrete concept is important to prevent the concept from losing its value and becoming a container concept. For example, in Alliander project, the circular economy is takes the form of a recycling economy, where the 80% of the building is kept. That is first good step to circular economy and much better option than demolishing the building right away, however when Alliander decides to leave the building, can this building be used one more time or endlessly or can it be used for another function or is it going to be demolished eventually? At some point the building will be demolished and the demolition material will be low-quality recycled in foundation of road construction, for example. *Then can it still be considered as a 80% circular building?*

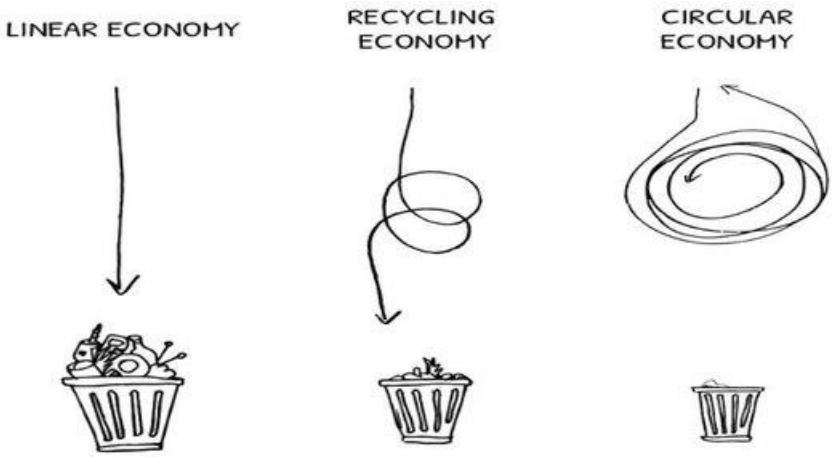

Figure 5.1: Circular economy interpreted as a recycling economy

Also circular economy interpreted as a sustainability, where energy saving or energy neutral buildings are considered as a circular project. Circular economy is part of sustainability, because it is inherently both restorative and rejuvenating. Because of this in a CE, materials retain their integrity, quality, utility and value..

Every party gives a different interpretation for CE. But the question remains: when is a project considered as circular and how do you know to what extent (%) is it circular?

There must be more clarity about the definition of circular economy. The question is whether there will be a clear definition, but there must be some direction, guideline for a definition of circular economy.

This offers opportunities to experiment in order to decide which circular principles should be taken into consideration. However experimenting especially in construction sector is more difficult because most of the time it is the public money.

5.1.2 Circular procurement

Almost all companies state that construction projects are being tendered based on the lowest price, also known as MEAT (Most Economically Advantageous Tender) criteria. Clients choose for the cheapest options and want to avoid risks at the same time. A contractor also wants to avoid risks because he is liable for the work he delivers and must be able to offer guarantees to the parties. However with the lowest price it is almost impossible to make a transition to circular economy.

As it stated before companies would like to be involved in the construction process earlier, so that they can offer circular alternatives. By collaborating early in the process, knowledge and expertise from different parties can be brought together, which facilitates the development of innovation, innovative solutions and value propositions. These wishes can be reflected in DBFM of Building Team contracts. In short-term fixed price, DBFM or Bouwteam could be opportunities for circular economy. With these options the chance that the client will get a circular or more innovative project is much greater. Therefore a lot of research have to be done on procurement and also other parties should indicate and think along what best procurement and tools will be.

There is also a research by Castelein (2018) where suitable contract type is recommended: Design Build Maintain and Remove (DBMR), which is comparable with lease contract model. Companies currently see opportunities for such a model in particular for interior and installations and possibly for façade elements, such as window frames. However for other building elements suppliers state that it can bring financial risks with it. Most buildings have a long life. This raises questions about the guarantee of the yield of the lease product on a long-term. For example, what happens with a bankruptcy of one of the customers of lease products.

5.1.3 Making more secondary materials available

It is quite striking to realize that there is not only scarcity of virgin materials, but also scarcity of secondary materials, while parties are being encouraged to purchase more secondary materials to contribute to circular economy. Levying taxes on primary materials can cause for using less virgin materials and making more secondary materials available and making it cheaper compared to virgin materials.

“There is one way to find out: levying taxes (taxes on emissions / environment),

because everyone understands that. For example, that is how we tackled problems regarding human right, that it should be banned in the Netherlands, otherwise you will get a fine." - Manufacturer of building materials A.

Laws and regulations are not made for new materials. Often the law and regulations are made for what is already possible and what we can make. But now it turns out that within the circular economy we want other things and that laws and regulations are made because we happen to have that solution at that time. But there are also other solutions now. We can maintain the original purpose of these law and regulations by slightly adapting these.

5.1.4 Directing role

Circular economy is only at the very beginning of transition. To be completely circular, there is all the parties from the supply chain needed. However, there are parties who try to make a transition within their own organization, within what is now possible in the field of circular economy. Parties who already want make a transition and do not want to wait until the other parties, can see what they already can do in advance to bring the transitioning forward. Back in the days a construction company would only built, but now there are construction companies who can develop, design en party recycle and demolish, where they can take several roles and can therefore have more impact in the supply chain because of his position in the supply chain. This offers opportunities for parties to stand out, to make a difference and to distinguish yourself from other parties by going for it and understanding the importance of CE, even though they do not know exactly how and it is going to be difficult for coming 2 or more years. As a result, a reduction in the supply chain can occur where one party takes several roles. However it does not mean that other parties are not needed or not important. It is now expected that companies who really want to make a transition, that they should come up with a innovation, that they should think along and should make a difference. And this could a new role for the supply chain.

The biggest necessity for the movement to the CE must be tackled in practice, by both the market and the government, is to carry out circular projects. Creating market demand, which will result in competition and the currently (too) expensive materials will become more profitable for more and more developers.

Everyone within the supply chain has their directing role where they have take control over. In this case governmental parties should be responsible for law and regulations, whereas the construction companies should be responsible for introducing new circular technologies and building methods, producers for making more secondary materials or products and developers for creating new business models.

5.2 Social Relevance

This part is intended to reflect on current developments and in practice and added value of the findings in this research.

5.2.1. Current developments

If we look at current developments regarding circular economy, there are couple of developments at regional and national level. At regional level there is a development of province north Holland : action agenda (NL: Actieagenda circulaire economie Provincie Noord Holland). In this action agenda six elements are taken into consideration:

1. Innovation & entrepreneurship
2. Chain cooperation
3. Production of clean raw materials
4. Space
5. Regulation
6. Circular organization

However the question “how to realize these elements”, is not entirely clear and concrete

Also Bouwend Nederland, association of construction and infrastructure companies, develops tools to give substance to circular economy, lobbies for conditions for transitions to circular economy. An example for these tools are : analysis of sustainability in public procurement, sustainable material use (NL: Handvat Duurzaam Materiaalgebruik), seminar on MPG- BENG through BNL- Academy, adaptivity (NL: adaptief vermogen) of flexible design technology etc. So there is each year an analysis on how sustainability is taken into account in public tenders and what the possible trends are. Research conducted in 2016 shows that in only 10% of public tenders are asked for minimum requirements for sustainability (BNL, 2017).
Also in tools for sustainable materials use following aspects are taken into account, which correspondent to the findings of this research:

- legislation on sustainable material use
- opportunities for sustainable material use in the design stage itself
- opportunities for sustainable material use in the construction and maintenance phase
- sustainable varieties of building materials

One of the developments regarding circular economy on national level is Transition Agenda. Transition Agenda emphasizes following conditions for circular economy:

- a first series of innovative products and services for circular building
- a concrete demand for circular products and services, for example in public

procurement.
- knowledge, experience and instruments with sufficient people and the right people in the whole supply chain.
- no inhibiting, but stimulating rules and regulations
- sufficient incentives for R & D, experiments, prototypes and projects.
- understanding, support, recognizable benefits, awareness.
- common language and tools to indicate and measure circularity in projects.
- a specific plan to tackle the sustainability of the housing stock and one million extra homes in ten years together with 'De Bouwagenda' and to implement them as circularly as possible.
- accurate knowledge and a plan of approach to halve CO2 emissions in construction by 2030 and eradicate them completely in 2050

Most of these conditions match with the results of this research. For example, in the Transition Agenda, the emphasis is very much on common language for circular economy and indicators to measure it, as well as in this research. In addition, Transition Agenda is a first good step to stimulare circular economy but unfortunately it is not concrete how these conditions can be translated in practice. There is a lot policy in MRA, but execution of it in practice is lacking. Regional clients, such as municipalities, are very important to put these policies in action. Also there is nothing to little information has been included about secondary materials, procurement requirements and about their application in the Transition Agenda, while this research emphasizes the importance of secondary materials and procurement requirements/components which have an important impact in moving to circular economy.

Also according to NEVI, professional procurement organization of and for professionals, the ideal agenda is outlined in the transition agendas, but much more is needed for the shift to a circular economy in practice. "At the moment there are several example projects, some of which have already been cancelled. It often goes wrong because the parties do not trust each other well enough, because the cooperation is not going well or because there are uncertainties. These are hiccups s that have to be overcome. That is why this human side should have come more into the transition agendas. It is still people who have to do it all. But that is also the tricky aspect of the sustainability. "

5.3 SCIENTIFIC RELEVANCE

Research shows that in particular the construction sector is very promising for acceleration of circular economy. Het Groene Brein (2015) pointed out that the main driver for the introduction of the CE in the construction sector is the high destructive impact of the sector on the environment.

Literature research shows that in constructions industry there are a few examples of

circular buildings and infrastructure. There are only a few completely circular buildings in the world (Het Groene Brein, 2015). The reason for this problem lies in incomplete knowledge: the lack of a central definition about circular economy and the lack of knowledge about material scarcities (Het Groene Brein, 2015). Therefore there is little expertise, knowledge and experience in applying circular technologies in construction projects.

In order to enable an acceleration of circular economy in construction, it is important that all parties look at the same direction. According to researchers like Kok, Wurpel & Ten Wolde (2013), and De Grauw (2015), the lack of a commonly acceptable definition about circular economy and many components of it are also uncertain. A clear definition could help companies to base their circular goals on. At the moment there is a difference on what companies understand by the concept of circular economy. For companies, some elements of circular construction may be the same, but there is not a one central definition.

However, the circular economy must not be misinterpreted in terms of sustainability. Sustainability is the outcome of the implementation of circular economy. When the concept is examined further, it does not seem complete. Therefore there is a need for a clear definition for circular construction. First of all, this is important for the regional business community to work effectively with circular construction. Besides that, the awareness of potential clients is also important: the demand for circular construction can only arise when it is clear what exactly it is and what is being associated with it (De Grauw, 2015).

In addition, there is the challenge of what to do with low quality products and materials at the end of their life-cycles. The current return and refinishing processes are uneconomical in the long term. Morgan (2014) observed that there are large uncertainties around the future prices of raw materials. These uncertainties make it difficult to estimate the potential value of waste materials at the end of the useful life cycles of products (Adams, Osmani, Thorpe, & Thornback, 2017).

Uncertainty or inadequate knowledge regarding material scarcity should not be the reason for avoiding a potential risk. Tilton (2003) states that signs of threatening scarcity of materials are likely to become noticeable before depletion of virgin materials becomes a serious problem. Precautionary response and early warnings could be a strategy for material scarcity, even though there is not yet a sign of physical depletion of materials. Also Rammel (2003) stresses that the precautionary response can help as a framework and helps to avoid the barriers. In addition, Köhler, Bakker, & Peck (2010) describe that unawareness about the material scarcity and its consequence as a lack of knowledge. Bringing the material scarcity to the attention can be done by multidisciplinary communication where their knowledge can be shared. The foundation of material scarcity awareness is gathering knowledge from different stakeholders sharing this knowledge.

5.4 Cooperation

The research shows that (a) alignment of all the involved actors is one of the most important conditions. This means, knowing that the parties have the ambitions focused on circularity and the same understanding about the concept of circular construction. All companies emphasize the importance of cooperation. Based on the developed vision/ambition, it is possible to find parties that are open to participating in an innovative circular project. It is important that the right people and parties with knowledge and influence (governmental parties) are present in the network. However, the presence of motivation and enthusiasm is very important aspect too, which creates capacity and commitment. This ensures that involved parties in the network can cooperate more easily during the process. With regard to the role of cooperation between different actors, the research shows that cooperation between the parties can have a positive influence on the development of circular construction projects.

At the moment circularity is not a priority in construction projects, but (b) costs by executive parties and time by clients and architects are considered more important. Companies therefore indicate that they would like to be involved in the construction process earlier, so that they can offer circular alternatives. By collaborating early in the process, knowledge and expertise from different parties can be brought together, which facilitates the development of innovation solutions, value propositions.

Also the focus should be more on (c) doing, by doubting less and by starting a project can be achieved more than by thinking about it for too long. However circular construction is still a search for everyone and is accompanied with many uncertainties. Despite the great enthusiasm and willingness for circular economy among the front runners, many companies are not yet working on it. They wait till there are more insights available. According to almost all companies, there is a need for inspiring examples and success stories where it becomes clear what is financially and technically possible.

5.5 Conclusion

Harmonize CE definitions – One of the key sources of confusion is the lack of harmony or agreement on a suitable definition of CE for the construction sector. This may compromise the process of decision-making and eventually lead to ineffective policy interventions. Successfully implementing CE in the construction sector needs a definition that covers the whole construction supply chain to provide understanding of material flows in the economy (not just at the waste/ recycling stage). This will create a “Common Reference Framework” assess progress against and meet set objectives as well as identify source of inefficient use of resources and opportunities for resource efficiency.

The following definition that will be suitable for the construction sector is recommended: Circular Economy (CE) in the construction *sector is an economy where waste is reduced (at the initial phase of CE) or eliminated altogether (advanced CE) and where the resources are used, reused and recycled*. This definition suggests that resources in the construction sector should be used in an environmentally sound manner. However, this is only possible through developing new business models, innovative avenues of employment, improved well-being and new methods to promote sustainable use of resources. SDL, with its focus on developing new services, provides a means of proposing innovative solutions that promote the 3R's of reducing consumption of natural resources, reuse of products and recycling of waste in construction. It may be inferred that SDL offers a multidimensional approach that achieves sustainability goals in the construction industry through integration of circular innovative technologies based on comprehensive waste reuse and recycling.

CHAPTER. 6 CONCLUSION

This chapter analyzes the answers to the research sub-questions formulated in chapter 1. In doing so, possible answers for the main research question will also be explored. In the following sections, limitations of this research and recommendations for further research will be discussed.

6.1 RESEARCH QUESTIONS ANSWERED

In this section the sub-questions and main research question will be answered. In order to answer these questions, the main findings from literature and interviews will emerged. The formulated main research question is as followed:

What are the factors impacting successful adoption of circular innovative technologies by supply chain partners in the construction industry?

This central research question is divided into four sub-questions that each answer the part of the main question: (1) circular innovative technologies, (2) adoption of service dominant logic in construction industry, (3) activities that support parties to make a transition and (4) obstacles and opportunities for these activities. By answering these sub-questions one after another, the main research question will eventually be answered.

Circular innovative technologies in practice means that efforts are made to reduce virgin material use, using as many secondary materials and demountable parts of a building as possible and making designs that are flexible, dismountable and repurposable. However transitioning to circular economy cannot achieved by only adopting circular innovative technologies, there is also social innovation needed. In the concept of social innovation, besides the organizational side of sustainability, attention is also paid to social value creation. Social innovation is the domain of human interaction. Talents and needs develop in these mutual relationships and networks.

There Service Dominant logic is suitable theory, which deals with interaction between the parties for value co-creation. SDL makes different types of tangible and intangible innovation possible by facilitating exchange of information, skills and capabilities in an economic system either through education and training or by incorporating them into products. SDL is consists of eleven foundations premises which are translated to construction industry and eleven important themes within circular economy. Using SDL as a framework there are interview questions created corresponding to eleven themes. After analyzing the interviews 4 main activities are emerged which support the parties to promote the utilization of circular innovative technologies in construction projects. Following main activities that emerge from the research for a possible acceleration of circular construction projects are: (a) clear definition of

circular economy with quantitative circular indicators, (b) circular procurement (c) making more secondary materials available by consistent rules and regulations and (d) directing role.

6.1.1 Clear definition of CE

According to supplying companies there is a lack of demand from the client for circular economy principles to be incorporated in construction projects. The lack of (a) uniform and clear definition for circular economy, makes it difficult for the clients to ask for circular economy in their (b) procurement.

6.1.2 Circular procurement

Priority in the procurement of construction projects are mainly based on lowest price and time. However they can ask for fixed price. Also as a circularity measures mainly the energy saving or waste separation are taken into account in construction projects.

6.1.3 Making more secondary materials available

Circular economy needs long-term thinking which makes the requirements for materials uncertain. To meet these requirements (c) the secondary materials have to be processed which can make these materials more expensive than virgin and/or modern materials. As long as these materials are cheaper than secondary materials the preference will be for virgin materials. This can be counteracted by levying taxes on primary materials or making subsidy available on secondary materials. However it is only possible when there is enough secondary materials are available.

6.1.4 Directing role

Circular economy is only at the very beginning of transition. To be completely circular, there is all the parties from the supply chain needed. However, there are parties who try to make a transition within their own organization, within what is now possible in the field of circular economy. Parties who already want to make a transition and do want to take (d) directing role, can see what they already can do in advance to bring the transitioning forward. This offers opportunities for parties to stand out, to make a difference and to distinguish yourself from other parties. As a result, a reduction in the supply chain can occur where one party takes several roles. However it does not mean that other parties are not needed or not important. It is now expected that companies who really want to make a transition, that they should come up with a innovation, that they should think along, should make a difference and stop blaming each other, pointing fingers and waiting for other parties. And this could be a new role for the supply chain.

The biggest necessity for the shift to the circular economy must be tackled in practice, by both the market and the government, is to carry out circular projects. Creating demand, which will result in competition and the currently (too) expensive materials

will become more profitable for more and more supply chain parties.

6.2 LIMITATIONS

This research has several limitations.

Interviews

The interviewees were chosen from various parties in the construction sector. There are consultants, clients, architects, developers, recyclers, construction companies and suppliers interviewed to get a clear image of all the different parties. However, the findings depend on limited number of interviewees, in most cases 2 or 3 interviewees from each sector. In addition there are mostly circularity promoters and specialists in the field of circular economy have been interviewed. Also there is unfair distribution of interviews per sector, for example, there are more than 3 governmental parties/clients interviewed. It was a conscious choice because in previously read literature clients are seen as the only party that could promote circularity and that are responsible for transition of circular economy.

Case

In this research there is only investigated how the metropolitan region of Amsterdam deals with circular economy/ Also the involved parties in this region are interviewed. This makes it difficult to create characteristics for this region since other regions are not taken into account.

Service dominant logic

There has not been much research done on this theory, SDL, in construction industry. The foundational premises are interpreted to construction industry. The theoretical framework has proved to be sufficient to answer the main question. However, because it is applied in the construction industry, where not many comparable papers could be found, it's validity and the way it is interpreted cannot be verified.

6.3 Recommendations

In this part the recommendations to the construction sector as a whole, to the researchers organization and to the science for further research will be given.

6.3.1 Recommendations for scientific research

In the various interviews, many topics emerged that require extra attention to further strengthen this research. This mainly concerns the following topics:

Interviews

Interviewing parties who are not only circularity promoters or specialists in the field of circular economy. This can provide different and possibly innovative insights. Also interviewing even number of clients compared to other interviewed parties can cause for more even balanced interview.

Case

It could be interesting to do a research in other metropolitan regions, such as Rotterdam or Utrecht to see how these regions are dealing with circular economy and how metropolitan region of Amsterdam distinguish itself from other metropolitan regions. Also to see how these regions are in transitioning to circular economy.

Service dominant logic

Since SDL is applied for the first time in construction industry there is more research needed on application of Service dominant logic and interpretations of foundational premises to construction sector.

In addition, it is also interesting to look at circularity from contracting point of view to see how the circular projects are initiated and realized, what the main reason was for realization of a certain circular project(s). *Is this stated in contract before realizing the project? If so, how? What is asked from the suppliers/contractors?* In some of example cases in this research the circular principles are later on in the implementation phase applied, which raises the next question: *Is there a contract needed for circular economy or should circular economy be a standard for every construction project?*

Also the following questions are interesting for future research:

How is circularity measured? What is 100% circular and where is that based on? Which measuring instrument is most suitable for circular economy in construction industry?

6.3.2 Recommendations to the construction sector

Based on the findings in chapter 4, the following recommendations have been made to all stakeholders in the construction sector.

Recommendations for Demanders

Recommendations for Clients – The following recommendations are made to the clients or demanders in the construction sector. Clients are the end consumers in the construction value chain:

- *Commit to the Circular Economy* – It is recommended that clients commit to the CE and insist on buying only those buildings or taking up those construction projects which incorporate CE principles. People who buy houses or building in the Netherlands, should be open to the idea of CE and willing to test different approaches for constructing the building. This will go a long way in getting CE to be adopted by more numbers of people in the Netherlands.
- *Use CE Based Procurement Processes* – It is recommended that the client find suppliers or construction partners with the appropriate mindset and competencies to innovate in the area of CE. Clients should clearly and unambiguously communicate to the potential construction supply chain that only CE approaches must be adopted in the building. The tender brief must include CE objectives and the outcomes that the client wants to achieve. The brief must include at least one question on CE to test whether the potential partner is familiar with the concept of CE or not.
- *Encourage Innovation & Collaboration* – Since CE is still a new to the construction sector, it requires innovation and collaboration for appropriate implementation. The client can encourage partnership workings and be ready to use new products and systems in his / her projects. The client be open to new methods of procurement and test new materials.
- *Establishing Clear Performance Requirements* – It is recommended that clients move away from the current prescriptive methods used for specifying building design to a performance oriented method of design and procurement. This involves informing the supply chain partners what the building must achieve or do post incorporation of CE. For example, the clients can say that the building must achieve double savings in electricity consumption as compared to a non-CE building of a similar size.
- *Identify Minimum Design Life* – Clients can establish a minimum design life for the various parts of a building. The design and construction teams should then use CE principles for the various parts to last that long. For example, infrastructure based constructions should be highly durable. Shorter life projects like kitchens should be designed such that they can be easily dismantled, reused and recycled.
- *Adopting a Whole Life Cost Approach* – Investing in CE can be based on whole life cycle costs of the materials used, of the product and building. These costs include initial cost of capital, costs of maintenance, operations, repair, upgradation and end of life costs. CE principles can then be used to identify

how these costs can be reduced through leases, sharing, design for durability / adaptability and ease of maintenance.

- *Involve the Supply Chain* – It is important for clients to understand that implementation of CE depends on leveraging those supply chain partners who can innovate. The client communicate clearly what he or she wants to achieve from the CE project, find partners that share similar ambitions and then implement the project. The client should help build trust, share risks, try new approaches for CE implementation and leverage suitable opportunities.
- *Refurbish the building rather than demolish* – It is recommended that clients can first identify whether they want a brand-new building or whether an existing one can be refurbished / modified. This is because one of the cardinal principles of CE is to retain the resources that are already contained in existing structures to reduce waste and consumption of raw materials.
- *Use Demolition Audit* – If the client is going to demolish a building, it is recommended that a pre-demolition audit is conducted. This will help identify those materials and products that can be salvaged and recycled back into the new construction. This audit can then be used to identify how much new material is required for procurement in tender documents.

Recommendations to Government Authorities - The following recommendations are made to the government who come under the demanders category in the construction sector. These recommendations are to ensure policy and regulatory support and to introduce those measures that provide technical and financial support to CE initiatives.

- The government of the Netherlands as well as regional and local authorities, especially those dealing with construction waste should devise and implement regulations related to recycling of waste. Regulatory instruments can set quality targets for recycling and reuse.
- The government of the Netherlands can issue codes and standards for recycled materials to ensure minimum performance limits that increase the likelihood of their reuse resulting in resource conservation.
- The government can also institute special charges for waste, incineration and landfills. These pay as you throw charges will increase the changes of waste getting recirculated back into the system.
- The government can invest or secure funding for putting in place infrastructure that ensures the efficient recycling of material waste back into the economic system.
- The government can establish special funds for initiatives related to construction CE.

Government support as indicated above will ensure that (a) construction waste recycling initiatives are effective in reducing or even eliminating the extraction /

consumption of natural resources, (b) compliance of construction businesses with CE initiatives, (c) stimulus for the end to end implementation of CE construction projects and (d) innovation in CE project development in the construction sector.

Recommendations for Suppliers

Recommendations for Designers / Architects/ Engineers – The following recommendations are made to the designers / architects who come under the demanders & supplier's category in the construction sector.

- *Advising the Client* – The designer has a unique role to play in promoting CE as design forms the first stage of any construction project. Therefore, it is recommended that the designer can proactively identify where CE principles could be incorporated in a project and the client advised on the benefits inherent on adopting such an approach. Designers should advise clients on such aspects as reuse and recycling of products, building design that optimizes resource consumption, enables ease of maintenance, facilitates upgradation, adaptation and demounting as well.
- *Incorporate CE Principles in Construction Design* – It is recommended that designers incorporate CE principles into building design. The designers should be able to examine how the design specifications address the principles of a CE and identify further opportunities for implementing as many CE principles as practically possible.
- *Involve Manufacturers of Construction Products* – Involving manufacturers of construction products early in the design phase will help the designer to leverage any new innovations that the manufacturers have developed. The manufacturers should be able to showcase any products that incorporate circular economy principles.
- *Match Design with Expected Life of the Construction Product* – It is important for the designer to identify the life of the building that is being designed. For example, a bridge will have a longer life (say 100 years) than a pavement that is expected to last 10 years. The designer should then align choice of materials, design elements etc in accordance with this project life of the structure. This will promote efficient material design, generate less waste and promote higher levels of reuse over subsequent 'lives' of the construction projects.
- *Easy to Maintain and Upgrade Designs* – The designer can design the building such that it is easy to maintain and upgrade whenever necessary. The various structural elements should be designed such that they last longer and be built with minimum waste.
- *Flexible Design* – It is recommended that the building be designed such that it is flexible enough for future reconfigurations and reuse.
- *Design for Demounting* – Demounting refers to deconstruction methods that preserve whatever building elements can be used in a new construction. It is recommended that new buildings be designed such that its components, connections and fixtures can be easily dismantled and reused.

Recommendations for Producers – The following recommendations are made for suppliers who come under the supplier's category in the construction sector.

- *Develop End of Life Options for Construction Products* – It is recommended that suppliers identify end of life options for construction products. As far as possible, products should be design such that they can be recycled into the construction ecosystem. Other products can be designed for remanufacturing. These aspects of the product should be clearly communicated in the product specifications sheet.
- *Develop Return Schemes* – Suppliers should implement return schemes for components and materials supplied to construction firms. These schemes enable the supplier to recover the value of materials whenever the building gets demolished and reduce their reliance on fresh material inputs. This scheme can also help identify those agents in the construction sector who can reuse or recycle these products.
- *Offer Product as Service* – Suppliers are uniquely placed to offer their products as a service in a commercially viable manner. By following the product as a service model, the benefits of the product are sold rather than the product itself. This is line with the philosophy of SDL. The supplier retains ownership of the product and assumes responsibility for it at the end of its useful life. This enables longer term relationships with the customer as well.
- *Reduce Waste During Manufacturing* – The supplier should be able to estimate the quantity of waste that is generated during the manufacturing or production process and targets should be set for annual reduction of waste.
- *Design for Remanufacture* – Remanufacturing refers to the rebuilding of an original product using reused, recycled parts from an old product. The original product should hence be designed such that it can be used again for manufacturing new products as the end of its life.
- *As much as possible, use Secondary Materials* – It is recommended that manufacturers use recycled products in their new products as much as possible. This means using as much recyclable material as possible without negatively impacting the quality of the end product.

Recommendations for Demolition Contractors – The following recommendations are made for demolition contractors who come under the supplier's category in the construction sector.

- *Source of Feedback* – It is recommended that the demolition contractors be used by the other stakeholders in the construction sector as a source of feedback on how the design of a building impacts is ability to be efficiently demounted, its building materials recovered and reused. This is because demolition contractors are uniquely positioned to assess how buildings can be demolished and promoting the reuse of the building materials.

- *Using Pre-Demolition Audits* – Demolition contractors should be able to draw up and use pre-demolition audits that help them identify if there are viable opportunities for the reuse of demolished materials and components.
- *Maximising Reuse* – It is recommended that demolition contractors prioritize the reuse and recycling of building materials in ways that retain the value and utility of the building materials. They should be able to demonstrate to the clients the economic and environmental benefits of such reuse.
- *Monitoring and Reporting* – Demolition contractors should be able to assess how much material is reusable, how much gets recycled into the system, how much construction material gets recovered / sent to landfills etc. The objective of such monitoring is to increase reuse and recycling as much as possible.

Recommendations for Demander & Supplier

Recommendations for Contractors – The following recommendations are made for contractors who come under the demanders & supplier's category in the construction sector.

- *Advising the Client* – Contractors should be able to identify where the proposed construction project would benefit from CE approaches and the client advised suitably. Contractors should be able to identify where products can be reused or recycled back into the system and on the use of modular construction units that can be easily dissembled.
- *Procure from Suppliers who follow CE Principles* – The contractor should be able to identify suppliers who have raw materials / product components that incorporate CE principles. For example, there may be suppliers who can supply recycled materials and these products match with the design being developed for a building. Contractors should partner with demolition firms and recycling centers from where reusable building materials can be procured.
- *Reduce / Eliminate Waste* – The contractor should liaise with designers, clients and manufactures to see ways and means of eliminating if not reducing as much construction waste as possible during the lifecycle of the building. This includes the construction, operation, maintenance and end of use stages of the building. It is recommended that the contractor set targets for waste reduction, recycling and reuse during the construction project and work with the construction company to achieve these.
- *Procure and use used or recycled materials* – as far as possible the contractor should promote the use of reused and recycled products in construction projects. He should be able to present a compelling business case to the clients for the procurement and reuse of recyclable materials.
- *Use of Modern Technology & Process* – There are certain technologies & processes with proven capability in reducing waste. This includes lean processes and Building Information Modelling (BIM). BIM acts as a centralized data warehouse of information related to design, materials and components

across the life-cycle of the building. Such information can be used for the purposes of maintenance, reuse, recycling. BIM will also show how the building can be demounted / deconstructed in future.

Recommendations to Bouwend Nederland

The researcher's organization is a branch of a construction firm. The following are the recommendations that are made for the organization to help transitioning the Dutch construction sector into a CE.

Creating Awareness through Knowledge and Education – The findings reveal that a big obstacle in the adoption of CE is the lack of knowledge about its concepts. In this scenario, the researchers organization can play an important role in creating awareness about CE through the following:

- The organization can lobby with government bodies and other funding agencies for the funding and grants required for research & development in CIT.
- Construction Firms operating in the CE in the Netherlands should push for organization laws that ensure only those products with sustainable design are procured.
- The organization can liaise with the government and other players in the construction CE and can facilitate more dialogue between R&D institutes, businesses and with civil society.
- The organization can support awareness programs related to educating the public on sustainable construction, sharing of resources, on re-use and recycling.
- The organization can invest in the professional training and skill enhancement of its permanent staff in areas related to CE.
- The company can work to secure those commitments from the public and private sectors that ensure construction products are produced and consumed in an environmentally sustainable manner.
- The organization can partner with research firms and with agencies at the national/regional/local level to develop new circular solutions for the construction sector.
- The organization can work as an advisor or consultant to construction firms on CE practices
- The organization can facilitate partnerships between NGO's, citizens and user groups, promoting awareness amongst the public on CE issues related to the construction sector.
- The organization can support the diffusion of innovations that lead to CE implementation in the construction sector.

REFERENCES

Adams, K. T., Osmani, M., Thorpe, T., & Thornback, J. (2017, February). Circular economy in construction: current awareness, challenges and enablers. In *Proceedings of the Institution of Civil Engineers-Waste and Resource Management* (Vol. 170, No. 1, pp. 15-24). Thomas Telford Ltd.

Akadiri, P. O., Chinyio, E. A., & Olomolaiye, P. O. (2012). Design of a sustainable building: A conceptual framework for implementing sustainability in the building sector. *Buildings*, *2*(2), 126-152.

Atkinson, R., & Flint, J. (2001). Accessing hidden and hard-to-reach populations: Snowball research strategies. *Social research update*, *33*(1), 1-4.

Bastein, T., Roelofs, E., Rietveld, E., & Hoogendoorn, A. (2013). Opportunities for a Circular Economy in the Netherlands. *TNO: Delft, The Netherlands*.

Bazeley, P. (2009). Analysing qualitative data: More than 'identifying themes'. *Malaysian Journal of Qualitative Research*, *2*(2), 6-22.

Cesaroni, F., & Duque, L. C. (2013). Open innovation and service dominant logic: application of foundational premises to innovative firms. *Harvard Deusto Business Research*, *2*(1), 17-34.

Chesbrough H (2003) Open Innovation: The New Imperative for Creating and Profiting from Technology. Harvard Business School Press Books, Boston.

Converse, Paul D. (1921), *Marketing Methods and Politics*. New York: Prentice Hall.

Damen, M.A. (2012). *A resource passport for circular economy: An assessment of the possible content and format of a resources passport in order to successfully contribute to the achievement of the circular economy*. Master Thesis. University of Utrecht.

Eichholtz, P., Kok, N., & Quigley, J. M. (2010). Doing well by doing good? Green office buildings. *American Economic Review, 100*(5), 2492-2509.

Ellen Macarthur Foundation. (2014). *Towards the Circular Economy: Accelerating the scale-up across global supply chains*.

Ellen MacArthur Foundation. (2016). BUILT ENVIRONMENT:CASE STUDIES A COMPILATION OF CASE STUDIES FROM THE CE100. Retrieved on 25 July 2017 from https://www.ellenmacarthurfoundation.org/assets/downloads/Built-Env-Co.Project.pdf

Evans, S., Vladimirova, D., Holgado, M., Van Fossen, K., Yang, M., Silva, E. A., & Barlow, C. Y. (2017). Business model innovation for sustainability: towards a unified perspective for creation of sustainable business models. *Business Strategy and the Environment*, *26*(5), 597-608

Fijneman, J. (2016). Innovatie bij Aanbestedingen. *Jaarbericht 2015 Aanbestedingsinstituut*. Bouwend Nederland.

Fischer-Kowalski, M., & Swilling, M. (2011). *Decoupling: natural resource use and environmental impacts from economic growth*: United Nations Environment Programme.

Geraedts, R., Prins, M., & Bin Mohd Noor, M. (2015). *The CE Meter: An instrument to assess the circular economy capacity of buildings*.

Gemeente Amsterdam. (2016). Circulair Innovatieprogramma. [Circular innovation program]. Retrieved on 11th of July from https://webcache.googleusercontent.com/search?q=cache:pqdL3Vw3zOIJ:https://www.amsterdam.nl/publish/pages/802010/circulair_innovatieprogramma_2016-2018_met_een_doorkijk_naar_2025.pdf+&cd=1&hl=nl&ct=clnk&gl=nl

Ghisellini, P., Cialani, C. & Ulgiati, S. (2016). A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. Journal of Cleaner Production, 114, p. 11 – 32.

Gronroos, Christian (1994), "From Marketing Mix to Relationship Marketing: Towards a Paradigm Shift in Marketing," *Asia- Australia Marketing Journal*, 2 (August), 9–29.

Economic Board Utrecht. (2014). Advies over een Raamwerk voor Impactmeting voor Circulair Inkopen Retrieved on 10 April 2017, from http://www.economicboardutrecht.nl/sites/nl.economicboardutrecht.www/files/Advies%20Raamwerk%20Impactmeting%20Circulair%20Inkopen%20%28Eindversie%2017-10-14%29.pdf

Fischer-Kowalski, M., Swilling, M., Von Weizsacker, E. U., Ren, Y., Moriguchi, Y., Crane, W., & Kemp, R. (2011). *Decoupling: natural resource use and environmental impacts from economic growth*. United Nations Environment Programme.

Het Groene Brein. (2015). *De 10 grote vragen van de circulaire economie*. Retrieved from http://cdn.hetgroenebrein.nl/wp-content/uploads/2015/06/10-Grote-Vragen-voor-de-Circulaire-Economie-INFOGRAPHIC-02.pdf

Huysman, S. S. S. (2017). Performance indicators for a circular economy: A case study on post-industrial plastic waste. *Resources, Conservation and Recycling, 120*, 46-54.

ING Economics Department. (2015). Circulair Bouwen: Kansen voor slopers en groothandels. Retrieved on July 10, 2017 from https://www.ing.nl/zakelijk/kennis-over-de-economie/uw-sector/bouw-en-onroerend-goed/circulair-bouwen.html

Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. Resources, Conservation and Recycling, 127, 221-232.

Köhler, A. R., Bakker, C., & Peck, D. (2010). Materials Scarcity: A New Agenda for Industrial Design Engineering. Delft University of Technology, Delft, the Netherlands.

Kok, L., Wurpel, G., & Ten Wolde, A. (2013). Unleashing the power of the circular economy.

Report by IMSA Amsterdam for Circle Economy.

Grauw, D. (2015). Closing the loop in real estate: Implementing the circular economy at the educational sector. Delft University of Technology, Delft.

Kraaijenhagen, C., van Oppen, C., Bocken, N., & Bernasco, C. (2016). *Circular Business: Collaborate and Circulate*: Circular Collaboration.

Lacy, P., & Rutqvist, J. (2016). Waste to wealth: The circular economy advantage. Springer.

Lohmann, W. (n.d.). Duurzaamheidscriteria-in-Europese-aanbestedingen. Retrieved on March 16,2017 from http://www.pprc.eu/wp-content/uploads/Duurzaamheidscriteria-in-Europese-aanbestedingen.pdf

MacArthur, E. (2013). Towards a Circular Economy—Economic and Business Rationale for an Accelerated Transition. *Ellen MacArthur Foundation: Cowes, UK*.

Mas-Verdú, F., Ortiz-Miranda, D., & García-Álvarez-Coque, J. M. (2016). Examining organizational innovations in different regional settings. *Journal of Business Research*, *69*(11), 5324-5329.

Morgan J (2014) The Great Resource Price Shock. Green Alliance, London, UK

Nambisan S, Sawhney M (2007) The Global Brain: Your Roadmap for Innovating Faster and Smarter in a Networked World. Wharton School Publishing, Upper Saddle River, NJ.

Nederland circulair in 2050. (2016). Rijksbreed programma Circulaire Economie. Het ministerie van Infrastructuur en Milieu en het ministerie van Economische Zaken, mede namens het ministerie van Buitenlandse Zaken en het ministerie van Binnenlandse Zaken en Koninkrijksrelaties.

Nelissen, K., & Versteeg, G. (2016). Circulair inkopen. Wegwijs is circulair inkopen voor de Facility Manager. Den Haag: Facility Management Nederland.

Normann, Richard, & Rafael Ramirez. (1993). "From Value Chain to Value Constellation: Designing Interactive Strategy,"*Harvard Business Review*, 71 (July–August), 65–77.

Pianoo Expertisecentrum Aanbesteden. (nd). Sustainable Public Procurement. Retrieved from https://www.pianoo.nl/public-procurement-in-the-netherlands/sustainable-public-procurement-spp/spp-themes/circular-procurement/getting-started-with

Romero, D., & Molina, A. (2011). Collaborative networked organisations and customer communities: value co-creation and co-innovation in the networking era. *Production Planning & Control* 22 (5–6), 447–472. Retrieved from dx.doi.org/10.1080/09537287.2010.536619

Rust, R. (1998). What is the domain of service research?. *Journal of Service Research*, *1*(2), 107-107.

Savitt, Ronald (1990), "Pre-Aldersonian Antecedents to Macromarketing: Insights from the Textual Literature" *Journal of the Academy of Marketing Science*, 18 (Fall), 293–301.

Schoolderman, H., van den Dungern, P., van den Beukel, J., van Raak, R., Loorbach, D., van Eijk, F., & Joustra, D.J. (2014). Ondernemen in de circulaire economie, nieuwe verdienmodellen voor bedrijven en ondernemers. Amsterdam.

Schlesinger, Leonard A. and James L. Heskett (1991), "The Service-Driven Company," *Harvard Business Review*, 69 (September–October), 71–81.

Shaw, A. (1912), "Some Problems in Market Distribution," *Quarterly Journal of Economics*, 12 (August), 703–765.

Sheth, Jagdish and A. Parvatiyar (2000), “Relationship Marketing in Consumer Markets: Antecedents and Consequences,” in *Handbook of Relationship Marketing*, Jagdish Sheth and A.

Schoolderman, H., Van den Dungen, P., Van den Beukel, J., Van Raak, R., Loorbach, D., Van Eijk, F., & Joustra, D. J. (2014). *Ondernemen in de circulaire economie, nieuwe verdienmodellen voor bedrijven en ondernemers*. Amsterdam: Tromp Drukkerij.

Stephenson, W., 1953. The study of behavior: Q-technique and its methodology. University of Chicago Press,Chicago, Ill.

Sociaal-economische Raad (SER). (2016). *Werken aan een circulaire economie : geen tijd te verliezen*. Retrieved from https://www.ser.nl/~/media/db_adviezen/2010_2019/2016/circulaire-economie.ashx

US EPA. (2008). *Sector Performance Report*. Retrieved on 25 July 2017 from https://nepis.epa.gov/

Vargo, S. L., & Lusch, R. F. (2004). Evolving to a new dominant logic for marketing. *Journal of marketing*, *68*(1), 1-17.

van Dijk, S., Tenpierik, M., & van den Dobbelsteen, A. (2014). Continuing the building's cycles: A literature review and analysis of current systems theories in comparison with the theory of Cradle to Cradle. *Resources, Conservation and Recycling, 82*, 21-34.

Vargo, S. L., & Lusch, R. F. (2016). Institutions and axioms: an extension and update of service-dominant logic. *Journal of the Academy of Marketing Science*, *44*(1), 5-23.

Vargo, S. L., & Akaka, M. A. (2009). Service-dominant logic as a foundation for service science: clarifications. *Service Science*, *1*(1), 32-41.

Weijnen, T., & Berdowski, Z. (2009). *Het totale inkoopvolume van Nederlandse overheden*: Instituut voor Onderzoek van Overheidsuitgaven.

Wilkinson, S. J., & Remoy, H. T. (2011). *Sustainability and within use office building adaptations: A comparison of Dutch and Australian practices.* Paper presented at the PRRES 2011:

Proceedings of the 17th Pacific Rim Real Estate Society Annual Conference.