Circular Buildings the Urban Living Lab Way

A Practical Facilitation Tool as Guidance for a Circular Building Process as Collaborative Ecosystem

Quinton Jie

MSc Thesis Industrial Ecology

Universiteit Leiden

TU Delft Delft University of Technology

ICE-Amsterdam IMPLEMENT CIRCULAR ECONOMY

Circular Buildings the Urban Living Lab Way

A Practical Facilitation Tool as Guidance for a Circular Building Process as Collaborative Ecosystem

Thesis Research Project by

Quinton Jie

Leiden University: S1326589 | Delft University of Technology: 4281799

In partial fulfilment of the requirements for the degree of

Master of Science
in Industrial Ecology

Date of Submission: February 3, 2016

First Supervisor	: Dr. Nancy M.P. Bocken, Faculty of Industrial Design Engineering, Delft University of Technology
Second Supervisor	: Dr. ir. Jaco N. Quist, Faculty of Technology, Policy and Management, Delft University of Technology
External Supervisor	: Douwe Jan Joustra, Director of ICE-Amsterdam (Implement Circular Economy Amsterdam)
Contact	: Q.k.g.jie@gmail.com

Cover Image: “Home symbol with chimney made from jigsaw puzzle pieces”, retrieved from https://www.flickr.com/photos/horiavarlan/4640819987

Executive Summary

The built environment is a major contributor to current global problems of resource depletion, pollution and climate change. It is an energy and material intensive sector that relies on the availability of resources. It is an environment where multiple human activities come together that can have their direct and/or indirect impacts within its environment in which the three pillars of sustainability (i.e. People, Planet, Profit) are present. In the case of the Dutch building sector, here presents a challenge, as it is currently highly reliant on the importation of these materials.

The concept of Circular Economy introduces new opportunities to become increasingly innovative and becoming more material efficient. For the Dutch building sector in particular, this means becoming less reliant on the importation of building materials. The concept promotes a resilient industrial economy that is self-fulfilling, by relying on renewable energies, minimising wastage, and eliminating the usage of toxic chemicals. There is a focus on developing new strategies for reduction, reuse and recycling of materials and energy, also known as the '3R' principles. It promotes the development of new business based on performance over consumption, closing loops and using a systems approach. To change the traditional discourse to such a circular approach a paradigm shift is necessary. As a consequence, the building sector will need to challenge existing uncertainties and consider opportunities that a Circular Economy may offer.

To explore the opportunities in what way circular buildings could be beneficial in the building sector, three cases (Town Hall Brummen, Circular Office Alliander and Cradle-to-Cradle City Hall Venlo) were analysed in this thesis. Evidence from these case studies supported the hypothesis that asking the questions in terms of functional performance needs instead of technical details promotes creativity. This can be achieved by putting your vision and ambitions on the market for tendering. By asking for a vision and ambitions, the specific requirements and conditions what normally are given were open for discussions, suggestion and ideas. This creates more flexibility and adaptability for all the parties along the Circular Building Process, which is also strengthened if a client is asking to design a building process instead of using a pre-designed building adjusted for a Circular Economy. Asking the client to participate in the creation of the process means that it becomes more important to explore the opportunities through collaboration and co-creation in an open innovation network and finding the right partners to do so.

Living Labs is a concept that builds on the idea of open innovation networks. Its main focus is to use all the external ideas as a source for supporting innovation processes through experimentations. It uses a user-centric perspective to develop usable products and services. For the built environment it is obvious that a user-centric perspective is necessary, because they determine what the building context will be. They are often the ones who will be using the building according to their needs. However, involving the users actively in the innovation process to reveal their 'real' needs is not always the case. Therefore, Urban Living labs is a good starting point to explore and reveal the needs of the user for a Circular Economy in the building sector. Therefore, the following definition is being developed for the building sector: *Urban Living Labs is a systematic approach that integrates research and innovation by collaborating with multiple stakeholders (public-private-civic partnerships) to co-create, develop and validate new products, services, businesses and technologies for sustainable value in territorial ecosystems in which the user is actively involved.*

Based on the concepts of Urban Living Labs and a Circular Economy the three cases are analysed to develop a conceptual Circular Building Process that is seen as an example of a Collaborative Ecosystem. For this conceptual model the circular building process is assumed to be an ideal process that is derived from the case studies and supported by the findings of the interviews, workshop and literature. The aim is to improve the traditional building process by embedding the principles of Urban Living Labs.

The Urban Living Labs principles are extended further within the execution phase. Where the focus of Urban Living Labs is based on the experimentation by collaborating and co-creating in an open innovation process, the focus of the execution phase is based on the translation of experimentations into viable options towards a fully functioning product or service. The Circular Building Process as Collaborative Ecosystem contains five phases: 1) Envisioning Phase, 2) Co-Creation & Exploration Phase, 3) Experimentation Phase, 4) Execution Phase and 5) Monitoring & Evaluation. To guide the client towards a circular building process, a practical facilitation tool is included in the model that incorporates these phases, which helps the client by constructing circular buildings in a similar manner.

The tool is a sequential approach of decision-making that is focused on co-creation, collaboration, integral designing and experimentation within a circular building network. It makes it practical by executing these experiments by trial-and-error learning. This should incorporate a circular shared value design proposition. The practical facilitation tool sees the Circular Building Process as a learning process where failures and making mistakes are allowed as long as you are able to improve using lessons learned.

When creating such a setting, it is important to build a relationship with the stakeholders that is based on trust and mutual benefits, which in the end of the process should result in a fully functional circular building that is in line with the vision and ambitions of a client. By going back and forth in aligning the shared goals between the client/user and the stakeholders, it makes the Circular Building Process Facilitation Tool iterative by nature.

Whilst the Circular Building Process as a Collaborative Ecosystem with its Facilitation Tool is still conceptual and not is being tested or validated yet, the proposed model does have the potential for adding value by combining Urban Living Labs and Circular Economy concepts. It adds value by guiding the client through the circular building process phases to make the right decisions, encouraging them not to be afraid to make mistakes and to go beyond their boundaries. It also helps to find the right partners as client to collaborate with a multidisciplinary consortium, explore new opportunities in Circular Economy through experimenting and trial-and-error.

By introducing Urban Living Labs concepts to a Circular Economy a link is made to explore the opportunities of open system innovation and new ways of doing business. Suggested further research (see Chapter 7 for more recommendations) includes to test the proposed facilitation tool as a standardised Circular Economy facilitation tool with more case studies and more ways in which Urban Living Labs concepts and Circular Economy concepts can work in partnership. In the cases, the idea of seeing buildings as resource depots was explored, but the challenge they were facing was to translate its potential value to preserve the use of resources and reduce waste into practice. It is an area that is underexplored, future research should study this field of interest to develop theories and concepts that help the building sector to become circular and material/resource efficient without compromising the quality of life.

Acknowledgements

This Thesis Research Project is representing the final work for the fulfilment of the Master of Science of Industrial Ecology in Leiden University and Delft University of Technology. The research and the process to finish this project is something that cannot be achieved without the help of those who were involved.

First, I would like to thank my first supervisor Nancy Bocken, because at the moment we met she was enthusiastic, committed and willing to help me with my journey in the world of Circular Economy. Second, I want to thank Jaco Quist my second supervisor who helped me through the process at the beginning of my thesis preparation module in order to find and to get an approval for my first supervisor, because at the moment I started with my thesis preparation module there was no supervisor available that had the expertise in Circular Economy and was approved by the board of examiners of Industrial Ecology.

Both supervisors were of great help with their critical but thoughtful feedback and recommendations to structure my thesis research project that combines two relatively new scientific research areas; Living labs and Circular Economy. It was Jaco who introduced the concept of Living Labs and proposed to combine this concept with my field of interest the Circular Economy. Their critical view challenged me to become more critical and guided me to set my scope and boundaries into the right direction were needed.

Furthermore, I would like to thank Douwe Jan Joustra as my third external supervisor. As one of the pioneers in the field of Circular Economy in practice, he was knowledgeable and very inspirational for me to explore more what Circular Economy had to offer. With his expertise and social network, he shared his knowledge that provided me a lot of insight for finalising my research and appointed me to the right experts for interviews. I want to thank all those experts that I have interviewed for their time, effort, openness and willingness to share their information.

Last not least, my special thanks to my family and friends who supported me with their positive energy, interest, comments and valuable feedback to finalise my master thesis work. That I have inspired some of them as well to explore what the Circular Economy could mean for them, gave me even more commitment to continue within the field of Circular Economy. Hopefully, with this master thesis I can also inspire you, as reader, to explore what Circular Economy combined with the aspects of Living Labs have to offer.

Quinton Jie

Diemen, February 2016

Table of Contents

List of Figures

List of Tables

1. Introduction

1.1 Background

The concept of Circular Economy (CE) is gaining ever increasing attention in the Netherlands, as one of the potential motifs to understand why the current economic system is becoming outdated and needs to change. This is evident by the effort of the collaborative programme *the Netherlands as 'Circular Hotspot'* that will be presented as the new circular vision during the Dutch presidency of the European Union in 2016 (Circle Economy, 2015).

The attention of CE began with the publication of a series of reports by the Ellen MacArthur Foundation (EMF) 'Towards a Circular Economy' in 2012 (vol. 1), 2013 (vol. 2), and 2014 (vol. 3). In these reports the EMF explain why the current global economy needs to change radically towards a new economic model, hence, CE. This new economic model describes an (industrial) economy from a holistic point of view or life cycle perspective. It is about closing material loops and the creation of adding value throughout the whole value chain, and creating new economic and environmental opportunities. Closing material loops can be seen as a solution to countering environmental, economic and social problems caused by human activities in their relationship with nature.

The built environment is a major contributor to the current global problems of resource depletion, pollution and climate change. In fact, it is an energy and material intensive sector that relies on the availability of resources. It is an environment where multiple human activities are gathered that have their direct and/or indirect impacts within its environment where the three pillars of sustainability (i.e. People, Planet, Profit) are present (van Bueren, 2012).

The impact of these activities become clear in the findings of the Intergovernmental Panel on Climate Change's (IPCC) fifth assessment report (AR5). In this report they estimate that the world's buildings account for approximately a third of the global energy use and about one fifth of all greenhouse gas emissions (Chalmers, 2014; IPCC, 2014); worldwide 40% of the material resources are being used in the building sector (Khasreen et al., 2009). Additionally, the expected worldwide population growth of 42% to 2.7 billion people by 2050 (WBCSD, 2009) and the possibility that three-quarters of the world's population will be living in urban areas by the year of 2025 (Rogers, 1998) is also a development that need to be considered.

One of the main challenges for the building sector is to anticipate and act on the above findings, and make businesses future proof (Bocken et al., 2013). A paradigm shift is needed. Therefore, CE can serve as an opportunity to facilitate the building sector in developing new businesses and innovations based on closing loops and a systems approach.

Adopting the principles of CE in the building sector, companies need to rethink their way of doing business by using disruptive technologies and change models. Policy-makers, should support this by introducing supportive and strong regulatory frameworks (WBCSD, 2009). Thus, collaboration between multiple actors is needed to stimulate a market transformation towards circularity. To make this shift Figure 1 shows that it is not only about making compliances or reducing the costs and improving efficiency, but to go beyond and focus on how to embrace the opportunities to create adding value that benefits all parties.

Building on the need for a shift towards circularity this research will investigate the business-to-business built environment as a potential and suitable arena to facilitate the development of new opportunities for collaboration and business.

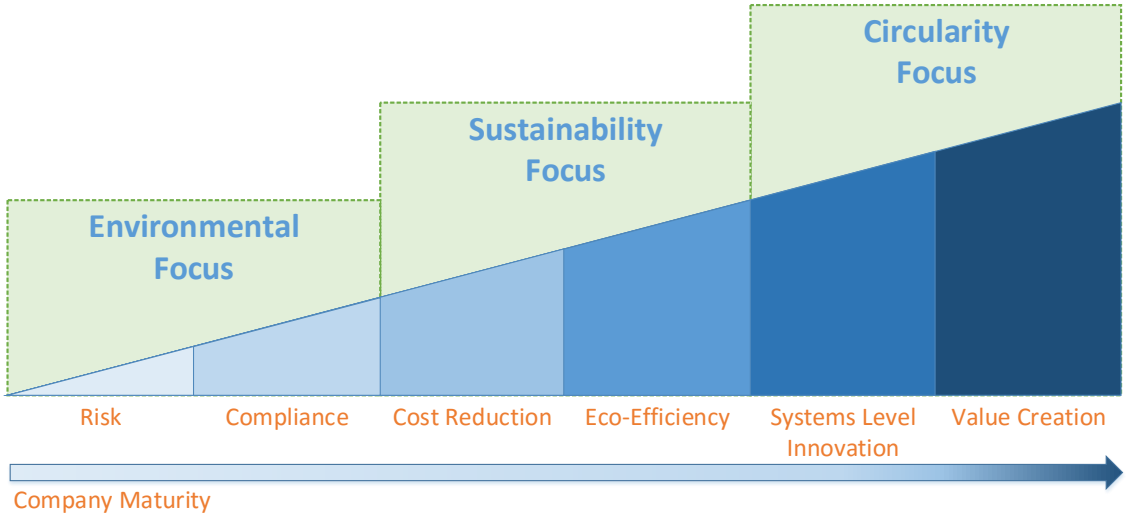


Figure 1: Shifting from compliance to opportunities for value creation [used with permission (Braam, 2014)*]*

1.2 A Need for a Practical Facilitation Tool

The development towards a more circular mind-set in the building sector is noticeable. Notable Green Deals, such as the Green Deal "*Circulaire Gebouwen*[1]" and the Green Deal "*Cirkelstad*[2]", have been signed by the Dutch Government, institutions and companies. Furthermore, an agenda is being published by *Ruimtevolk* initiated by "*Innovatiekring de Circulaire Stad*", which details ten points towards a circular city (Koenders and de Vries, 2015).

The active development towards circularity within the built environment is remarkable. Especially, for a small country like the Netherlands, in which the population density is high and is dependent on the availability of resources for building materials that is imported from other countries (Bastein et al., 2013). Thus, if the resources for building materials become scarce the prices will increase or fluctuate more, hence, become less predictable. Importing these resources will become more expensive and will affect the building sector opportunities significantly. To become less reliant on importing resources for building materials, the concept of CE can provide new possibilities. As a result, the Dutch building companies are challenged to come up with new innovative ideas to face the problems that will occur in the coming decades (e.g. energy usage, land usage and resource scarcity) and need to think more in terms of circularity (Doughty and Hammond, 2004). Therefore, the report of Actieagenda Bouw '*Routekaart Innovatieakkoord bouw*' (Roadmap Innovation Agreement Built Environment 2014) formulated three important themes for the innovation development of the Dutch building sector: 1) a user-centric approach, 2) the preservation of raw materials and energy, and 3) the future adaptability of buildings.

The above implies that the built environment is looking for new methods of innovation and a need to be more open-minded. If they do not change their way of doing business the higher the risk that the resources will be depleted in time, the prices of resources become less predictable, disruptions in the supply chain, and increased competition with different sectors (Ellen MacArthur Foundation, 2012). The current decision-making process to make the investments is still too focused on the short term

[1] Green Deal "Circulaire Gebouwen": Focus on the applicability of CE in buildings. The participants of this Green Deal are collaborating to develop monitoring measurements for circular buildings and look for opportunities of how materials can be used differently in designing buildings and chances to extend the life cycles of these materials (http://www.greendeal-circulairegebouwen.nl).

[2] Green Deal "Cirkelstad": A platform that focuses on facilitating multiple actors to develop cities without waste and shortage. No waste is about closing energy and materials flows as much as possible. No shortage is about involving all the citizens, finding the talents and not wasting them, but put them in full use (http://www.cirkelstad.nl/).

and monetary based benefits. Moving towards a more value based decision-making process is recommended.

The economic system for the building market needs to change in the coming years or decades in order to stay competitive. In order to transform the current linear building sector towards a circular building sector changes in the value chain is necessary (WBCSD, 2008).

Companies should think through opportunities to manage the materials and resources (people, energy and materials) more efficiently and develop feasible circular business models. However, in practice, the building sector is still struggling with how to incorporate the CE principles into a profitable business model. They are aware that the built environment, as an energy and material intensive sector, is an area where lots of CE opportunities are ready to be exploited. The problems are where to start, with a huge pool of suppliers and producers in a very competitive market. For the first problem '*where to start'*, pilot cases of circular buildings are good starting points to learn from. By investigating pilot cases the lessons learned can form the input for a facilitation tool that supports companies to start a circular building trajectory. The lessons learned from the new cases will again provide new information and knowledge. As a result, a more concise definition of what CE is and what it means for the building sector can be developed and introduced.

For the second problem *'a highly competitive market'*, it creates a rather complex situation for clients or building companies to select the right parties to collaborate with that are willing to change their way of doing business to start with a CE related project (OPAi and MVO-NL, 2014). For this particular reason, aligning multiple motivations of different parties by incorporating sociological and political perspectives with a technological perspective, and experiences through practice is needed (Whyte and Sexton, 2011). The concept of 'Living Labs' can be the missing link to develop a tool that facilitates these complex situations to find the right parties for collaborative circular projects. The Living Lab concepts can be of great value, because it focuses on how users can be involved more in an open innovation process in a real life context (Almirall and Wareham, 2008; Schumacher and Feurstein, 2007b).

Relevance of Industrial Ecology

To link Living Labs with CE, the field of Industrial Ecology (IE) can be of added value. This is because decisions are being made by countering problems through a multidisciplinary approach by using a systems perspective and integrates aspects of different fields of expertise. Physical flows of our economies and redesigns of industrial processes are being analysed by using, for example, the following tools and methods: life cycle perspective, materials and energy flow analysis, systems modelling, and multidisciplinary and interdisciplinary research and analysis (Lifset and Graedel, 2002).

From the systems orientation, cities or buildings can rely on strategies of systems integration (Iveroth et al., 2013). This means urban solutions should represent the efforts of closing cycles as seen by a circular system (Iveroth et al., 2013; Rogers, 1998). For IE the purpose of systems integration is to increase the environmental performance (Ayres et al., 1997; Korhonen, 2001). Based on the purpose of IE, urban system integrations can contribute to increase the innovative capacity and continuous improvement of the system or systems. In other words, system integration is determined by the interactions between systems (input and output flows) and the relationships between natural environment and human use (van Bohemen, 2012).

The complexity of interactions and relationships between actors within an urban system on different levels can be explained from an IE point of view as an ecosystem (van Bueren, 2012). Thus, an urban ecosystem that deals with systems of systems just like nature does (Graedel and Allenby, 2010a). This dealing with systems of systems and its interlinkages can be visualised, according to an IE point of view, as a visualisation sketch shown in Figure 2.

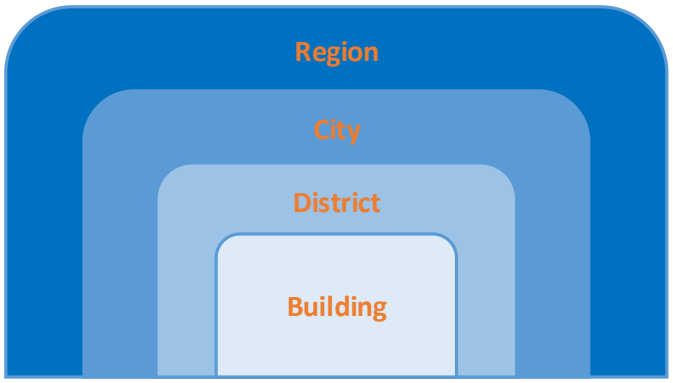


Figure 2: Industrial Ecology point of view dealing with systems of systems, the built environment.

In order to put more emphasis on circularity in the building sector a paradigm shift, a systems approach and new forms of collaborations are needed. Therefore, the field of IE can provide an opportunity to analyse parts of system within systems and the interactions between multiple actors by considering the built environment as an ecosystem. These insights will contribute this research to develop a practical facilitation tool that supports parties to (re)develop (new) business models and innovative development processes. For the development, the tool will investigate how Living Lab aspects can be applied to support the transition towards a circular built environment.

1.3 Relevance to Industrial Ecology

As mentioned, the field of IE takes a broad and multidisciplinary approach and is focused on analysing the physical flows in our economies and redesigning the industrial processes to take care of sustainability problems. This give the impression that collaboration is necessary. In fact, within the field of IE collaboration and businesses are been seen as something for granted. However, the link with IE and collaboration to develop new businesses or more specific open innovation and co-creation to develop businesses is still an area for further research (Mentink, 2014).

This thesis will explore the importance of collaboration or co-creation within an open innovation to provide a more comprehensive support to shared business innovations. As a result, it offers interesting insights into finding the right partners for collaboration or co-creation in an open setting and how it can be facilitated by taking a systems perspective that support companies in innovating their businesses.

1.4 Research Question and Scope

Building further on the above, it becomes interesting to explore the possibilities in which Living Lab concepts and CE excel by combining these concepts to stimulate and facilitate the building sector in becoming circular. Resulting in a circular building development process in which companies also can make a business out of it. To explore this field of opportunities within an urban context this thesis will focus on the following research question and sub questions:

How can Urban Living Lab aspects be applied in a circular economy to facilitate circular business innovation processes in the Dutch building sector?

1. What is the current state of Circular Economy in the built environment?
2. What is the relevance of Living Labs and Business Model (Innovations) for pilots for Circular Economy and how can they be used to evaluate pilots?
3. What can be learned from (selected) pilots with regard to governance/collaboration, Living Labs aspects and Business Model (Innovations)?
4. To what extent can the aspects of governance, value creation and capturing be applied in an urban Living Lab inspired facilitation tool?

Due to the time constraints and the focus on the Dutch Building sector, answering these questions will be limited on several aspects. The most important limitation and the scope of the thesis are:

- Living Lab as a concept is in literature mostly concerned with the creation of Living Labs or comparing Living Lab platforms. However, the focus of the thesis is to use certain aspects and be inspired by this concept. This scope concerns all the sub questions.
- The thesis will mainly focus on perspectives in which Living Labs are seen as methodology to involve stakeholders and gather data and some aspects of Living Labs as an environment, as discussed in paragraph 2.1. This concerns the sub question 2.
- The main focus is on the aspects of Living Lab as a methodology and as an environment. CE will be seen as an overarching concept. Concepts such as Cradle-to-Cradle or Industrial Ecology can help to explain the aspects of CE more extensively, but for this case these concepts are considered as a given. Nonetheless, the literature and documentation will be used to explain what CE is about and why it is needed in the building sector (concerns sub question 1).
- For business model innovation the previous mentioned scope is also valid, as explained in paragraph 2.3. However, in this thesis the scope of circular business model innovation is the way to value creation and captured in business models in order to make it future proof and turn it into a helpful business case to refer to. This scope concerns sub question 3.
- Pilot cases in the building sector for circular buildings is limited. Only a few are mentioned as circular examples and are also regularly used for practical references (sub questions 2 and 3).

1.5 Structure of the Report

The structure of the thesis report is based on the questions as stated above, see visualisation Figure 3. The scope, the need to shift the mind-set towards circularity in businesses in the building sector and the motivation for this research to apply Living Lab concepts in CE are given in the first chapter.

Chapter 2 will elaborate more on the theory of (Urban) Living Labs, CE and (circular) business model innovation and their relations (sub questions 1 and 2). The chapter will also detail the added value and business opportunities in the building sector. Given the added value and opportunities to incorporate Living Labs and CE in profitable business the main focus will be on the involvement of actors within a circular building process. This is translated into a Circular Building Process as Collaborative Ecosystem that is inspired by incorporating multiple concepts (Urban Living Lab, Urban Transition Lab, and Five Stages on the Path to becoming Sustainable).

In Chapter 3 the framework and methodology will be described that is based on a case study. For this case study three exemplary pilot cases were selected and shortly described for the analysis (sub question 2). Chapter 4 and 5 will elaborate more on the three given cases by comparing and analysing them according to the suggested Circular Building Process as a Collaborative Ecosystem (sub questions 3). The focus of Chapter 4 will be on the cases themselves and Chapter 5 will focus on the organised design workshop to validate the data provided by literature, interviews and desk research. Chapter 6 will examine the results and output of the previous two chapters in order to develop a conceptual facilitation tool that incorporates Living Lab concepts within circular building processes to (re)develop multiple business models (sub question 4).

Chapter 7 will discuss the findings of the case analysis and propose a new model for the Circular Building Process. It will list recommendations for further research and for clients. It will be finalised with an overall conclusion of the research by answering the main research question.

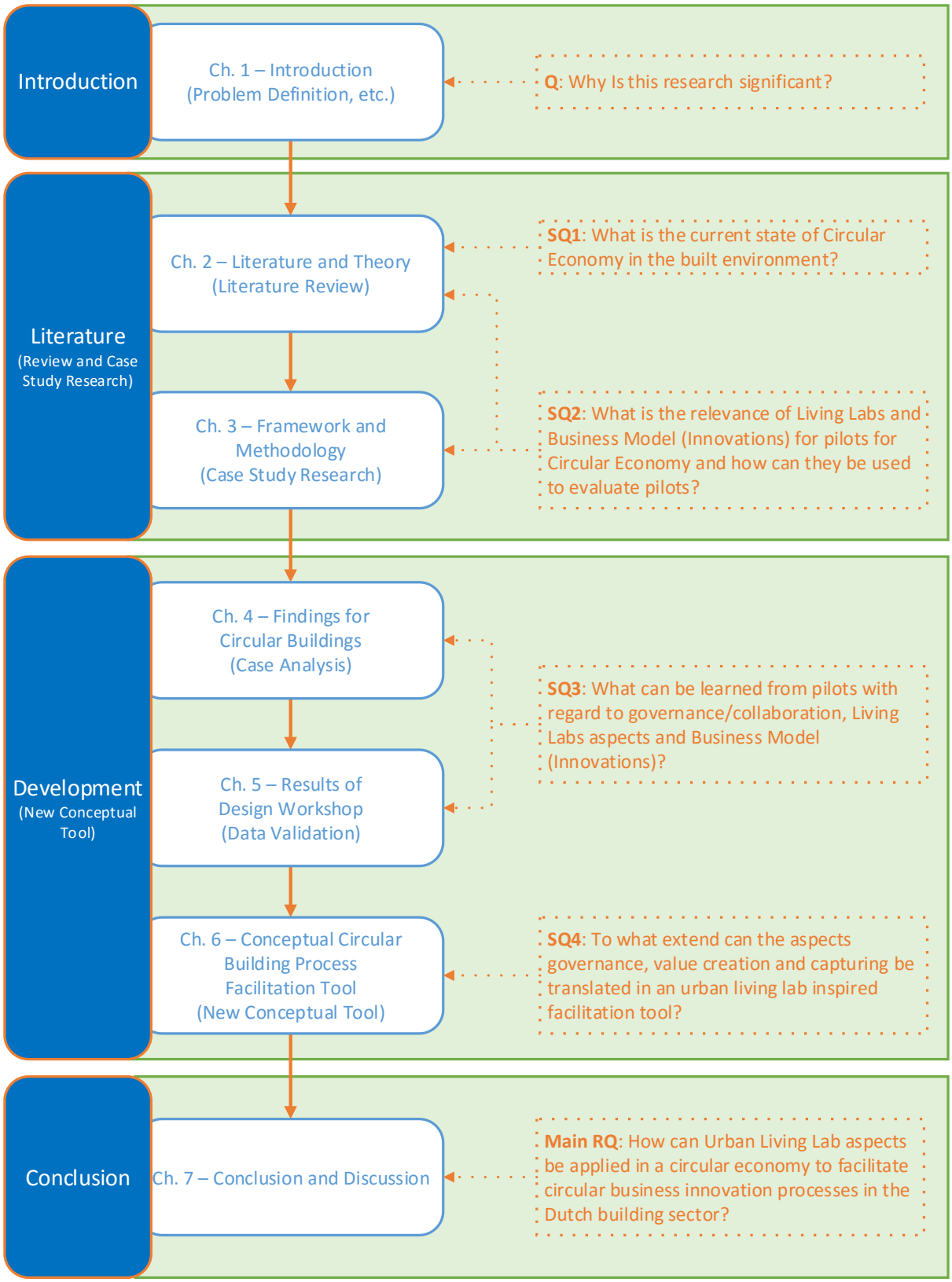


Figure 3: Structure of the Thesis Report

2. Literature Review

It is clear that there is a need to facilitate a transition towards CE in the building sector as an energy and resource intensive industry (Preston, 2012). Especially, with the fact that companies are still struggling in what way new or existing business models can close loops as much as possible, because it is still unclear how the building sector will develop in the future. It must become more sustainable, energy efficient (Chalmers, 2014; IPCC, 2014), and material efficient (Allwood and Cullen, 2012). This means making buildings energy neutral, through intensive cooperation between multiple stakeholders (van Amerongen and Driessen, 2014; Ministry of VROM, 2010; RVO-Nederland, 2014; WBCSD, 2009), and the paradigm shift of taxation on resources instead of labour (Project, 2014). Further research is needed on how (circular) business model innovation can make a system transition towards CE when radical innovations are presented (Mentink, 2014).

One of the potential possibilities to realise the transition is to see if the concept of Living Labs can be applied in the CE that supports the development of new business model innovations. However, the consensus in the literature is there is not much information available in which Living Labs are being used as an additional concept that can support CE in the building sector.

Therefore, these concepts will be discussed and described separately in this section. First, the concept of CE will be discussed in general and extended to what the added value and opportunities are in the Building sector. Secondly, the concept of Living Labs will be described and its relevancy for the building sector. Thirdly, circular business model innovation will be discussed to understand how created value of both concepts can be captured. Finally, a selection of tools and methods for both concepts will be discussed that forms the analytical framework towards a facilitation tool.

2.1 The Concept of Circular Economy

CE as a concept discusses a resilient industrial economy that has the ability to be self-sustaining, by relying on renewable energy, minimising waste, and eliminating toxic chemicals for usage. This is in fact based on how CE can be used as a new strategy that is focused on reduction, reuse and recycling of materials and energy also known as the '3R' principles (Yuan et al., 2006). It is based on closing loops as much as possible by 'design out' waste that is presented by the Ellen MacArthur Foundation as an inspiring and appealing 'butterfly' diagram (Figure 4) ('*Towards the Circular Economy*' 2012). In other words, both perspectives are about optimising industrial systems by efficient cycling of resources and energy by carefully managing the energy and material flows to close loops (Lifset and Graedel, 2002).

There are two types of circular flows that can be distinguished: the biological metabolism and the technical metabolism (McDonough and Braungart, 2010). According to McDonough and Braungart (2010) the biological metabolism is designed to make it possible for biological nutrients to re-enter the biosphere safely and build natural capital. Technical metabolism is designed to make it possible to preserve and circulate high quality technical nutrients that need to be avoided from entering the biosphere.

The current economic system is still a buy-and-consume market. This means the end-user buys a product, becomes responsible for it, hence, the owner, and not the producing or supplying companies. In order to introduce a CE system in the current market, performance based contracts should be considered instead of consumption based contracts (Ellen MacArthur Foundation, 2012) and strategies that supports the transformation, e.g. the Circular Economy Product and Business Model Strategy Framework (Bocken et al., 2015) or designing products that last (Bakker et al., 2014). From that respect it means that the customer is using the product, but the ownership of the products and its valuable material assets will remain by the manufacturer (Braungart et al., 2007). By focusing on performance based strategies, four opportunities can occur that creates value on design and material usage that is

detailed by the Ellen MacArthur Foundation (2012): 1) 'power of the inner circle', 2) 'power of circling longer', 3) 'power of cascaded use' and 4) 'power of pure circles'.

The 'power of inner circle' is based on keeping the circles as short as possible. In Figure 4 this can be linked to the cycle of maintaining the products as long as possible. The benefits of keeping these circles as short as possible along the supply chain are to achieve larger savings by reducing the costs of material, labour, energy and capital. When the circles are kept as efficient as possible, companies in the supply chain benefit most from using high quality virgin materials (Ellen MacArthur Foundation, 2012).

The 'power of circling longer' is based on going through more consecutive cycles of a certain material or product. It can be seen as a continual loop of reusing or redistributing as much as possible, but as well as using a certain product multiple times within a cycle. However, this will increase the operation and maintenance costs, but will extend the life-cycle of the product (Ellen MacArthur Foundation, 2012). Economic wise the benefit of this opportunity by making your products long lasting, in which the same product can be used over and over again, more revenue can be generated over a longer period of time and during its lifespan (Bakker et al., 2014).

The previous two opportunities to create value are based on reusing identical products and materials within a circular system, this aligns with idea that it is about reducing material usage for a certain product.

The next opportunity to create more value-add is the 'power of cascaded use'. This is related to certain products, components or material categories, which can be reused. It is not only for a specific product but for different product categories as well. In other words, extending the range of products in multiple markets by refurbishment/remanufacturing. This idea is related to the principles of Braungart and McDonough's Cradle-to-Cradle design in which 'waste equals food' (McDonough and Braungart, 2010). In other words, reusing certain product components and materials by upcycling can reduce the need of virgin materials or even replace it (Braungart et al., 2007).

The last opportunity to create added value is described by the Ellen MacArthur Foundation (2012) as the 'power of pure circles'. This opportunity is based on the full closure of loops in which all the products and materials can easily be separated into its purest form in order to recycle these again as 'high quality' resources for manufacturers.

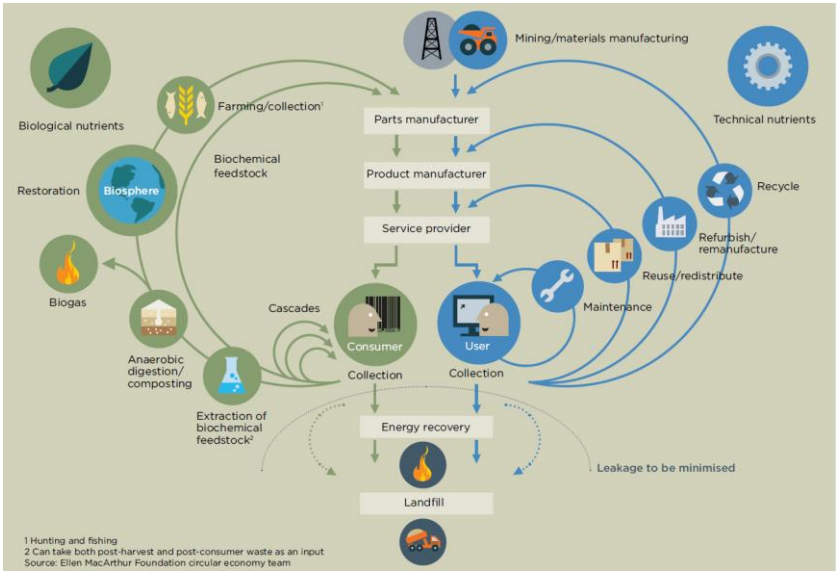


Figure 4: The Ellen MacArthur Foundation Circular Economy 'Butterfly' Diagram (Ellen MacArthur Foundation, 2012: 24)

By taking these four opportunities into consideration, the material productivity and efficiency increases for material and product related sectors, because the reliance on materials will be reduced and the focus can be more on innovation, long term relationships creation with users (Braungart et al., 2007; Ellen MacArthur Foundation, 2012) and job creation (Bastein et al., 2013; World Economic Forum, 2014). For companies in material and product related sectors this is more beneficial when the whole supply chain is efficiently structured and organised (Preston, 2012). The challenge then is to align the global supply chain in order to increase the productivity and upkeep the quality of materials used.

By aligning the supply chain the following barriers need to be overcome: geographic dispersion, material complexity, linear lock-in, and company-to-company cooperation (Preston, 2012; World Economic Forum, 2014). This can be achieved by finding and identifying the turning points throughout the supply chain and coordinating it in a way that supports the transition towards a circular economy (World Economic Forum, 2014). It is to think about creating shared value (Porter and Kramer, 2011) and using sustainability, in this case circularity, as the key driver for innovation (Nidumolu et al., 2009). Another way to coordinate the transition to CE is as follows. It is important that the materials that are being used are defined properly to use it in its purest form by promoting upcycling and creation of a materials bank (Braungart et al., 2007) and usage of the materials more efficiently (Allwood and Cullen, 2012). A materials bank represents a framework for intelligent materials pooling in which collaboration by co-creation of economic actors can be enhanced along the supply chain and the company itself will maintain the valuable materials. As a result, a mutually beneficial system of cooperation between companies can be formed in order to provide materials as pure as possible and turning them into products for customers that enable product-service strategies (Braungart et al., 2007).

However, the opportunities to use materials more efficiently that match the growing material demand and simultaneously slow down the depletion of available stock of resources are still problematic if no real constraint occurs (Allwood, 2014). If a real constraint occurs, e.g. war, than it instantly becomes a normal practice to use our materials more efficiently and share our products (Allwood, 2014). The current economy is still not in such a state in which the society and economy can participate actively in a two-way interaction recycling programme. This is because the incentive to recycle is not well aligned with consumer behaviour or constraint by physical limitations (EEA, 2015). Customers are willing to recycle, if they are informed and encouraged by the companies to return products and services that are provided (Bechtel et al., 2013).

In practice, it is not the consumers that are blamed directly. The companies and organisation may be blamed, because they have structured the economy in such a way that they shift the responsibility for our environment to us as consumers (Bechtel et al., 2013; Schouten, 2014). As consumers, they buy the products and become the owner, hence, being responsible during the usage of the products. The consumer usage phase can be considered a ‘black box’ for the producer, because what happens in this particular phase with their products is mostly unknown (Schouten, 2014). On the contrary, the theoretically idea of the ‘black box’ was based on making the producers responsible for their products during the whole life cycle, also known as ‘extended producer responsibility’ (EPR) (Mayers, 2007; Walls, 2006). Extended in this sense means that the producers should be responsible for the waste streams as well, because they are already accountable for the production and usage phase of their products due to product safety regulations and quality standards (Schouten, 2014). Thus, logically, they know their products and should know how to take care of their products after usage. However, this ‘black box’ theory did not achieve any results in making the producer more responsible for its products. Currently, the producers are still not fully aware of what happen with their products during and after its usage. After the usage phase, producers are not responsible for what happens with the waste streams, because often the municipality is still responsible for collecting and organising the waste streams in the Netherlands (Telleman and van den Kieboom, 2010). In other words, producers should become responsible for their products during the whole life cycle, this means as well establishing

logistics for waste collection and recycling services after its usage (Mayers, 2007), which can be done together with the municipality.

It seems that it aligns with the list described by Bocken, Short et al. (2014) of what a circular system should look like. In order to transform the current economy system to a circular system, the following aspects should at least be included (Bocken, Short et al., 2014):

- Encourage minimising of consumption or imposing personal and institutional caps or quotas on energy, water, goods, etc.;
- Maximise societal and environmental benefits and not only focus on economic growth;
- Closing loop systems with no waste allowed or discarded to the environment;
- Deliver products that are based on functionality and experiences (e.g. perform on demand, service based) instead on product ownership;
- Encourage the use of human creativity/skills by fulfilling and rewarding (work) experiences;
- Healthy and transparent competition by stimulating collaboration and sharing, and learn from each other instead of fierce competition.

2.1.1 SWOT-Analysis

Based on the above, the main characteristics of CE as a concept can be explained as an industrial economy that takes a systems perspective that is focused on closing loops of material flows by upcycling through value creation, design waste out and aligning the whole value chain.

To get a better understanding of what the added values are or what is lacking in the concept of CE, a SWOT-analysis can be performed. The analysis will be based on the literature. Therefore, the strengths and opportunities of CE are established according to the development of the concept in the current business opposing the linear business. Still, the linear economic systems have their strengths in the current business environment and every (radical) change comes along with barriers, obstacles and costs, thus, seen as weaknesses and threats. Based on this analysis, see Figure 6 and elaborated below, the added value for the building sector and the business opportunities can be explained.

<u>Strengths</u>

- **Design waste out** is one of the core principles of CE that challenge the producers to think more in product design that is optimised for a cycle of disassembly and reuse by taking a systems thinking approach (Ellen MacArthur Foundation, 2012; Mentink, 2014). It also challenges the producers to keep sustaining and adding value to their products with respect to material and energy efficiency and clean processing (Bakker et al., 2014);
- **Life cycle thinking** or systems thinking is also a core principle of CE to stimulate companies to optimise their systems by creating more value on the level of supply chain, which results in increased efficiency or a creation of new or additional values (Ellen MacArthur Foundation, 2012), hence, system innovations (see Figure 5);
- Strict distinction between **consumable (biological) and durable (technical) components** of a product. For the producer this distinction makes it possible to think what is safe to re-introduce their products into the biosphere or needed to be reused over and over again (Ellen MacArthur Foundation, 2012);
- **New pools of profit** concepts that are based on circularity creates new pools of profits. According to McKinsey and Co. in EMF (2012), opportunities towards a CE are estimated to account for $630 billion or €603 billion (European Commission, 2013) annually. For the Netherlands it is estimated to be worth a €7.3 billion business annually (Bastein et al., 2013).

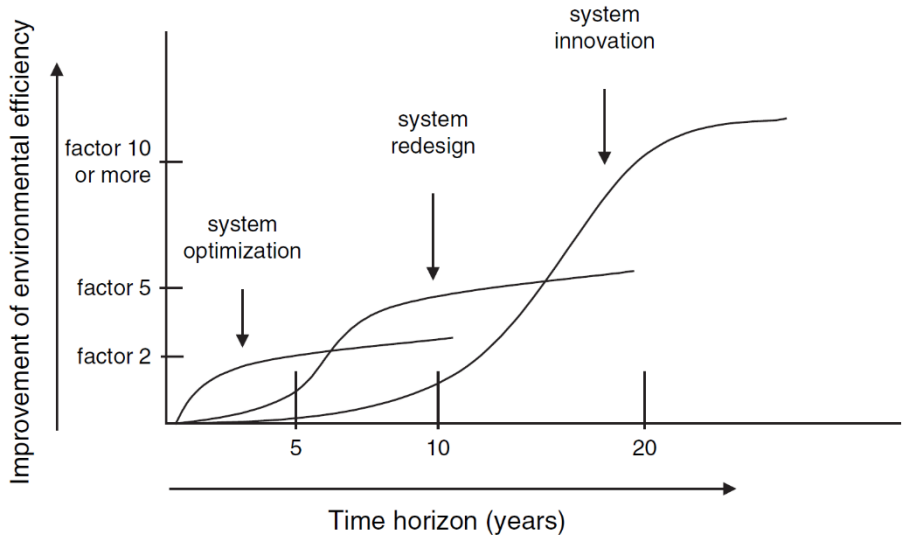


Figure 5: The potential of improving systems by optimisation, redesign and innovation for environmental efficiency (derived from (Tukker and Butter, 2007: 95)). System optimisation is based on making a system more efficient, for example improve the use of fossil fuels for cars more efficiently. System redesign is based on broadening the scope by including alternatives or substitutes, for car fuels hydrogen is an alternative. System innovation is based on societal needs and functions, in the case of cars as an example will be exploring new ways of transportation (Tukker and Butter, 2007).

Weaknesses

- **Strong as the weakest link**: the downside of a circular system is that it relies on linkages. Building resilience is considered to be a vital aspect in a circular system, because if one link fails and gets lost the whole system will collapse (Mentink, 2014);
- **Complexity of organisation and management**: within a circular system co-creation or collaboration with multiple actors is a key component. The downside of an increased collaboration with multiple actors is the increased cost, because of expanding organisational activities, structures and routines, supported by management systems and information systems (Mentink, 2014);
- **Need for new information**: for a circular system transparency and company-to-company cooperation are needed within the supply chain to ensure an effective production process. However, the access to and the need for new information can be constrained due to its **confidentiality** (Mentink, 2014);
- Building on the previous point **trust** (Berglund and Sandström, 2013), finding **mutual benefits**, and being aware that cooperation **increases dependency** (Boons and Baas, 1997) are necessary within the supply chain. If one these components are lacking a circular system cannot be effective and might collapse (see above).

Opportunities

- **Focus on functional needs:** theoretically CE is considered a concept that aims for sustainable development. However, in practice it is considered a 'weak' sustainability, because it still focuses on market based solutions (Tukker et al., 2014);
- **Incorporating social aspects** in CE will help to focus on improving the quality of living with less material requirements (Allwood, 2014). In other words, the big challenge is to still fulfil the needs of users, i.e. the urge to consume more, and simultaneously give back an improved quality of living with less material requirement.
- **Multiple value creation:** by focusing on functional needs, more social involvement and dynamic interaction will occur (Su et al., 2013). This can be beneficial for companies as well for the whole system by creating value outside the traditional boundaries (or business models) of an organisation (Jonker et al., 2012). As a result, **new collaboration forms** like co-creation can be developed in order to create value for multiple actors;

- **Standardised open architecture and interfaces**: from a business perspective this will stimulate new possibilities for product development to exploit the full potential of components and sub-assemblies during the entire lifecycle (Allwood, 2014).

Threats

- **Rebound effect**: if products are becoming more circular, energy and costs will be saved (Allwood, 2014). This can have as a result that the saved energy and cost will be used somewhere else that cannot be considered sustainable, for example taking the plane for a long distance vacation;
- **Lacks universal definition**: lacking a universal definition for a broad concept like CE have the risk to become a buzz word that only creates a temporary effect (Preston, 2012). Currently, concepts such as cradle-to-cradle, biomimicry, Industrial Ecology, sharing economy, Product-Service Systems (PSS) and lease economy are considered to be circular concepts (Jonker et al., 2012; Preston, 2012; Tukker, 2013);
- **Cost-oriented versus creation of added value**: reducing costs through economy of scale or minimising labour costs and increasing material use are still the main drivers of a company making decisions instead of creation of added value through innovation (Allwood, 2014);
- **Up-front investment costs**: the inevitably chance that the up-front investment costs will increase the risks for businesses on the short term, because the returns of investment and revenue generation will be more spread over time (Preston, 2012). Therefore, a strong business case is needed. This is also conflicting with the currently **short term minded shareholders** (Mentink, 2014). There is always a risk of damage in the usage phase of circular products that are financed according to a form of leasing or renting contracts. This may influence the position of a company towards a bank to secure the investment or loan.

Figure 6: Summarised SWOT-Analysis of Circular Economy

2.1.2 The added value for the building sector

From a CE perspective, one of the interesting developments for circularity in the built environment is to see all buildings as material banks or as Thomas Rau of Turntoo argued, a resource depot (Schouten, 2014). Generally, this makes sense because the lifespan of a building structure can last for at least 100 years (Brand, 1994; van Bueren, 2012). If all the materials are defined properly, sophisticated decisions can be made that generate economic benefits and make investments for material recovery worthwhile. By considering this development, the added value for the building sector is that the concerned parties need to collaborate by sharing and creating valuable data and technologies in order to overcome the barriers that circular buildings will bring (Kua and Lee, 2002). As a result, actors will be triggered to look beyond their boundaries ('out-of-the box' thinking) by using their expertise at its fullest. This will create more transparency in the market and avoid duplication. It is in fact a stimulus to use the gained knowledge and experience of each other that can guide you through the process of innovation and can provide unique solutions for each case (Bakker et al., 2014).

If the value chain of the building sector becomes more transparent, multiple actors will provide and share their knowledge of expertise in a more open manner. Doing so, the responsibilities of the actors will change as well. Especially if the building's lifecycle is of concern; this means other mind-sets of designing products and services will be developed that can be beneficial for the built environment for the very long term. For example, when the responsibilities and accountability shift to the suppliers, they will be triggered to think over their way of doing business by providing services instead of products to deliver to the demanding needs of their clients and users (Schouten, 2014) by selling light instead of lamps. This change of mind-set of selling services instead of products can be found in the Philips 'pay-per-lux' business case (Ellen MacArthur Foundation, 2011, 2012). From this point of view Philips as a supplier of light is a way of controlling the available resources more efficiently and simultaneously stimulates innovation for new business solutions.

For the building sector the way of thinking in services and lifecycles to extend the lifespan of buildings can be of great value, because considering the buildings as resources/material depots (Schouten, 2014) or to think in products that last (Bakker et al., 2014) new opportunities will arise. This can extend the lifespan of buildings, improve the quality of life and reduce the environmental impact by material and energy efficiency (Allwood, 2014; Allwood et al., 2011).

CE can support potential businesses to shift the mind-set towards making products or services by circular thinking, hence, a holistic approach. For circular buildings this means that it embeds as well the three dimensions of sustainability: Ecological sustainability (e.g. resource protection, ecosystem protection), Economic sustainability (e.g. long-term resource productivity, low use costs), and Social and Cultural sustainability (e.g. protection of health and comfort, preservation of social and cultural values such as equity, cultural diversity, education and skills[3]) (Kohler, 1999). Such a holistic approach means another way of designing buildings.

When all these dimensions are included, an integral approach with multiple actors is necessary and will enhance the value proposition of each actor in order to maintain their value. This can be approached from different perspectives, because a construction frame of a building, energy, material and water consumption of the building or the interior of the building have their own demanding values and lifespan. In other words, functionality and performance will be dominant, next to the strategies for resource/material depots, for the building sector when it becomes circular. From this respect, the report of MVO-NL and OPAi also mentioned that the residual value of buildings can differ dependent on the functionality of the products, e.g. a construction frame that can last for hundred years is less interesting in terms of residual value then for example interiors that will be changed several times within the same hundred years (OPAi and MVO-NL, 2014).

[3] For an extensive list of social and cultural sustainability criteria and indicators, see (Axelsson et al., 2006).

2.1.3 Opportunities for businesses

Continuing further on the idea of making buildings resource/material depots and look beyond the aforementioned 'black box', it can be assumed that it will influence the market structure and the interaction between manufacturers and buyers in the building sector. The way the 'black box' is explained can give some perspective on how EPR can be applied in the Dutch building sector. In fact, applying the idea to make the producers the owners for their products during the whole life cycle will open up new business opportunities. Producers will be stimulated to be more innovative and search for circular solutions. This means that it must not only be financially attractive but also including societal and environmental benefits, hence, creating shared value.

The challenge lies in the development and the approach of how products in this case will be designed, aiming for recycling or preferably upcycling of products. Because within a building, lots of valuable materials and embodied energy are stored and will be lost during the demolition. If this is not taken into account it affects the costs (Allwood, 2014). In what way it can affect the cost is based on the quality, decisions being made and the chosen approach/strategy for the building process from planning and designing phase to the construction phase till the operation and maintenance phase (Arditi and Gunaydin, 1997). To understand what the opportunities are for doing business in a circular building sector is to compare a traditional building process with a building process that embeds the principles of CE as elaborated in section 2.1 (see Figure 7). Before both processes will be compared for business opportunities it is necessary to know what type of building strategy can be used that will initiate the building process.

Within the building sector three general building principles can be described: 1) design and build from sketch (Ravetz, 2008; WBCSD, 2008), 2) renovate or retrofit existing buildings (Power, 2010; Ravetz, 2008), and 3) demolish buildings, hence, end-of-life (Icibaci and Haas, 2012; Power, 2010). All these principles have their own starting point; strategies and business models to strive for circularity that embed at least the three dimensions of sustainability: Ecological, Economic, and Social and Cultural (Kua and Lee, 2002).

Designing and building from sketch is favourable, because it is easier to incorporate CE principles and new technologies and to experiment with building design strategies and material use that fit in the 'modern' conditions of the society (OPAi and MVO-NL, 2014; WBCSD, 2008). The challenges and limitations are constrained by the degree of freedom of the regulations and available space for experimentations. The impact of constructing new buildings, however, is debatable (see for example (Power, 2010)), but it can show what the possibilities are for new business cases on the long term (WBCSD, 2008).

Renovating or retrofitting existing buildings is the most challenging of the three building principles. Existing buildings of today already contain a huge amount of material/resources stock that will be subject in future years for maintenance, upgrading, adaptation and rehabilitation (Ravetz, 2008). The challenge is to make these existing buildings more circular by adapting (new) technologies and design strategies to make it fit in the given building system or context. Especially, in developed countries this is an important development where adding value can be created (Ravetz, 2008; WBCSD, 2008).

Demolition is closely related to designing new buildings, because demolishing poor functioning and unsustainable buildings to replace them with new buildings, which will be more circular, seem an obvious choice to do (Power, 2010). However, the problems are costs, time, loss of valuable resources, pollution and waste streams that need to be taken care of during and after the demolition process. The challenge and opportunities for the building sector, is to consider these problems and incorporate it in a design or action plan in order to find fitting solutions. For example, integrate demolition in a new building design to reuse materials or to prevent it by introducing new concepts, technologies or

methods (Icibaci and Haas, 2012). Ideally, in terms of circularity demolition should not exist as an option, because in CE there is no 'waste' (McDonough and Braungart, 2010; Schouten, 2014).

Comparing these three general building principles, the main differences are related to the decision in what way materials can or should be used along the supply/value chain and more efficiently for constructing or renovating buildings (Allwood et al., 2011; Icibaci and Haas, 2012). Therefore, demolition should be reconsidered as an integrated part for renovation and also for new build to reuse valuable materials or resources as efficient as possible. The main driver for resource efficiency and circular building should be avoiding, preventing and minimising the use of resources while reducing the amount of waste (EEA, 2015) and simultaneous create multiple adding value (Schouten, 2014).

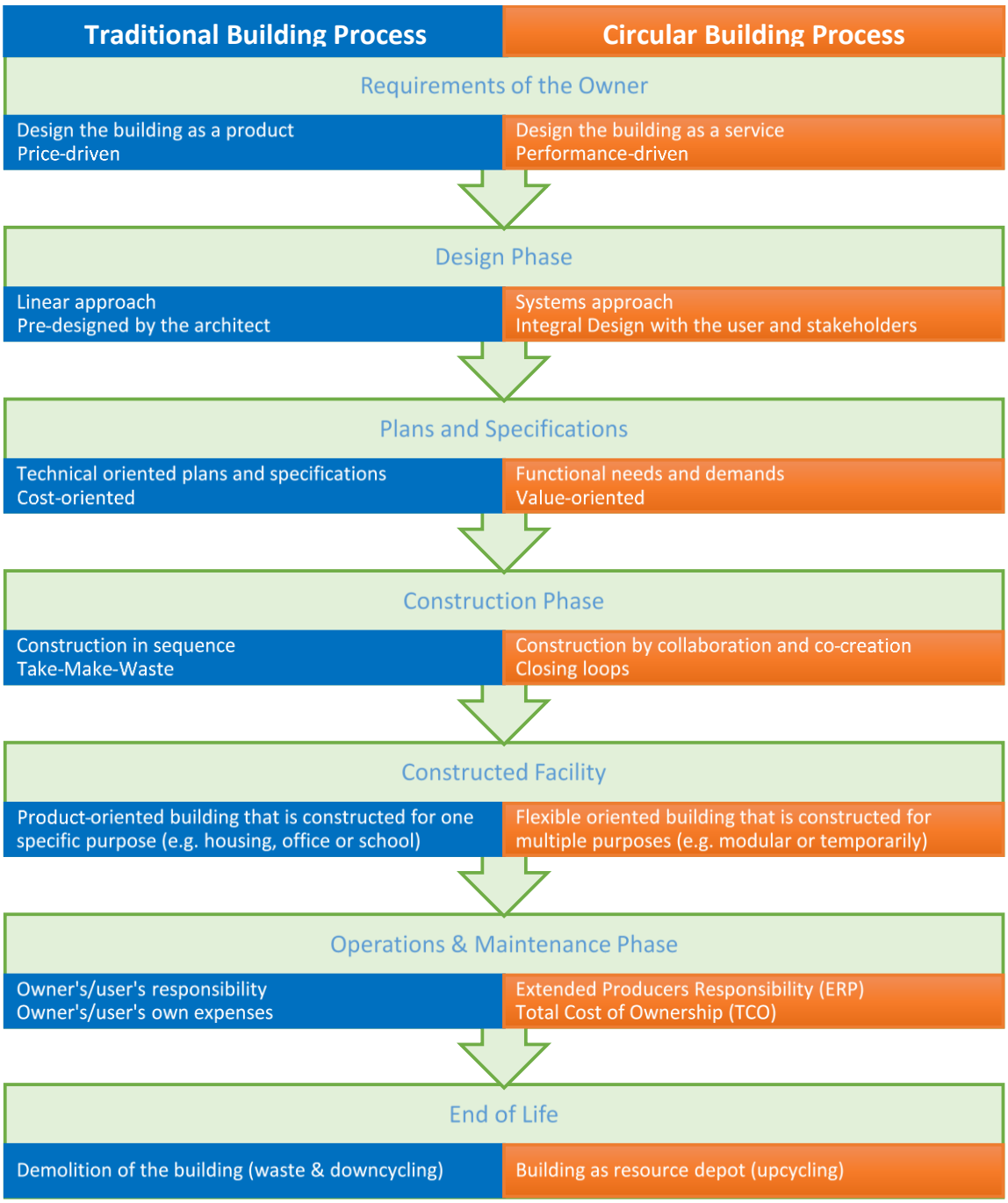


Figure 7: The difference between a traditional building process and a circular building process [main construction process is adapted from (Arditi and Gunaydin, 1997: 240) *and circular building process embedded the principles of CE as explained by Ellen MacArthur Foundation (2011), WBCSD (2008), McDonough and Braungart (2010), Allwood (2012) and Schouten (2014)].*

With the building principles in mind, what a building process that embeds the principles of CE does differently in comparison with the traditional way is to see a building more as service that fulfil the needs by focusing on functional performance instead of price (Tukker et al., 2014). It is understanding the functional needs of the user first and taking a systems approach before a building can be constructed with the technical details and not the other way around (Schouten, 2014). This will benefit the flexibility of a building, because at the beginning of the building process the costs are still low and the influence on a circular design to make impact is high (see Figure 8). Taken into account the general product characteristics of a traditional building for designing circular buildings as starting point; 1) built on site, 2) long life time (ranging from decades to centuries) and 3) inflexible once completed (van Hal and van Bueren, 2012), will help to generate and develop new solutions that are flexible to adapt changing user demands over time. However, after a certain point (where building performance and costs intersect, see also Figure 8), when the circular design will be specified, only small refinements or adjustments are possible to keep the costs low. If this point is reached, usually the resources, infrastructures and activities are already committed for the circular product design (Bocken, Farracho, et al., 2014), and it will be costly for bigger changes while the potential benefits will become smaller (van Hal and van Bueren, 2012).

By doing so, collaboration and co-creation within a circular building system become an iterative process for integral designing at an early stage. For the construction phase integral and iterative mean not a step-by-step or in sequence process like the traditional building process. These influence as well the responsibilities of the producers and suppliers, because with co-creation everyone becomes responsible for their performances. This is also strengthened by the aims of a circular building, the focus on functional performances that fulfil the needs and the CE principle that the producers and supplier keep the ownership of their products and materials (Schouten, 2014). This means that during the operation and maintenance phase and for the end-of-life of the building, they are responsible for what will happen with their products and materials with its value. This is not like the traditional building process where a building will be demolished, which creates waste and separates some valuable products and materials for reuse or downcycling, for example, use building material waste for asphalt or concrete.

As noted in the circular building process, it is interesting to think about products that are fulfilling certain needs or providing services to its user in which the producers or suppliers are still responsible for the products its entire lifecycle, for example, the concept product-service systems (PSS) (Tukker, 2013). However, this can be done for new buildings to keep track records of all resources or materials used for construction. The challenges, as mentioned, are the existing buildings that can be seen as material stocks that need by time maintenance, upgrades, renovation and adaptations (Ravetz, 2008). It has the potential to become one of the major growing businesses in the near future (Ravetz, 2008).

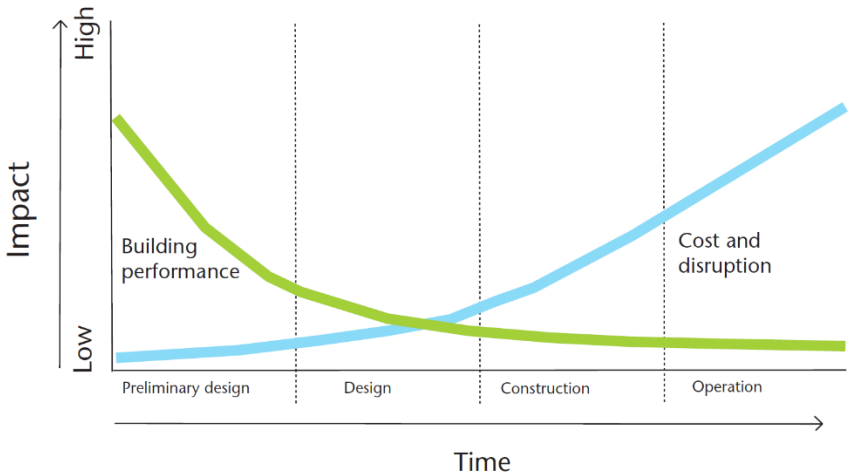


Figure 8: The benefits of early integration of sustainability on the agenda [derived from (WBCSD, 2008: 50)*].*

Global stocks for most materials being used in buildings, infrastructure, equipment and products are still sufficient to meet the anticipated demand (Allwood and Cullen, 2012). Sufficient stocks of valuable materials in the built environment and technologies being used are also the reason that urban mining is getting more attention (Brunner, 2011; Steentjes, 2013). Thus, if circular solutions focus on the human needs, valuable materials and embodied energy, that can be preserved, will be beneficial socially, environmentally and economically in the long term.

The composition of materials will be used to construct or design temporary construction for buildings, which can easily be disassembled or deconstructed when it is needed and can be used over and over again (Schouten, 2014). As a result, the way to manage the resources and materials for the manufacturer will change. By this means the disassembled materials will go back to the manufacturer, because they will become responsible for their resources and materials for its entire life cycle. Nonetheless, by doing so, manufacturers still need to be aware that they do not create a rebound effect (Allwood, 2014). If products become more circular it will save energy and costs, but there is still the risk that the saved money and released energy will be spent elsewhere that is not sustainable. For example, taking the plane more frequently with your saved money to go on vacation. For companies it is important to anticipate on the developments in order to guarantee the continuation of its business and fulfilling future demands. Therefore, changes in business and plan of actions are needed to prevent rebound effects and simultaneously reduce material demand effectively in the Dutch building sector.

According to Allwood (2014), two broad approaches can be used. First, the designers of products and processes along the entire supply chain must collaborate in order to develop significant opportunities to save materials. The second approach is to develop technologies that are more efficient in the use of intermediate stock materials without generating much waste or scrap that have no value. Ideally, this means the built environment improving material efficiency to reduce the environmental footprint and introducing new technologies, 'intelligent' products, standardised preassembled components and advanced materials (Doughty and Hammond, 2004); even though, the approaches described by Allwood (2014) and the ideal situation for sustainable cities of Dougthy and Hammond (2004) are focused on designing. In essence, the idea is to design products that are long lasting, create no waste and can be used through several generations of products. A standardised open architecture and interfaces as the basis for new product development can open up new ways to fully use the potential of a product during its lifecycle (Allwood, 2014). A building can then become a resource depot to manage the resources and add value for future use (Schouten, 2014), which can open up new forms of a building materials market and potential for (new) business model innovations (see for some business model innovation examples (Bocken, Short et al., 2014)).

Another challenge for companies, is to fulfil the needs of their stakeholders; this also includes the users/clients, with less material requirement but still improving their quality of life. In addition, the current economy is not the only system for critique, it is the society as well. Due to the current economic system that is driven by materialisation, our dominant societal culture also adapted a lifestyle that fits in and became unsustainable. In that respect the CE is promising to make more resource efficient products, however, in literature and practice it is still too focused on materials and environmental aspects and their impact, and still lacking on social and economic aspects.

Literature is scarce on the impacts of social aspects and economic aspects if circular economy is applied, except for one published article of Greyson (2007) that proposed a preventative approach for waste which also includes other global impacts. This new economic instrument called 'precycling insurance', suggests that decision-making can be led by the market rather than by prescriptive regulation or educational campaigns for CE (Greyson, 2007). Unfortunately, just as Greyson (2007) concluded in his article, people know the consequences of their current lifestyle and know they need to change, but how to act and how they can influence the current situation is still an area that needs more research.

The manner in which users or stakeholders can be involved, might be the key to changing the current mind-set and might lead to a more circular society. This is also one of the challenges that companies need to face in order to come up with better solutions to become future proof (Nidumolu et al., 2009), hence, becoming more circular as a business internally and externally.

If we want to move towards a more circular society and economy, we must not leave it to economic market mechanisms as we know it (Ellen MacArthur Foundation, 2012), but really need to think in terms of what the needs are from the user and act to it (Porter and Kramer, 2011). Porter and Kramer (2011) argue that companies must look at the social issues and act by fulfilling the social needs; they must become more like social enterprises. The Living Lab concept can support this to 'set things in motion' and really emphasise valuable knowledge, co-creation and collaboration with active users by treating them as equal partners and discover the real social problems. The important thing to understand, as a company or organisation, is to make clear what the core motivations or intrinsic values are for the stakeholders and users, and match these with viable business models (Osterwalder et al., 2014; Porter and Kramer, 2011). It is about changing a commercialised mind-set to products and services on demand (i.e. perform on demand) instead of products and services, which are is supply oriented (Schouten, 2014).

These perform-on-demand driven initiatives become easier because of the fact that the current technology, like smart phones, tablets and internet keep people increasingly connected. In fact, the current society and its relationship to be connected to everyone from local to global is evident with social media, sharing apps, peer-to-peer networks and crowdfunding websites (Schouten, 2014). By this means, co-creation and supporting each other to fulfil the needs will play a major role in the development of our society, economic system and way of doing business (Jonker et al., 2012). The results that Information and Communication Technology (ICT) is more integrated in our daily life is becoming more visible in the built environment, for example, the growing interest of Smart Cities (Caragliu et al., 2011), in which open source, bottom-up and decentralised systems are considered as some key components to gain more competitive advantage (Schouten, 2014) and new strategic agendas (Caragliu et al., 2011). This development towards more ICT related resources as driving factor for businesses and lifestyles is also called the Third Industrial Revolution (Rifkin, 2008).

From the CE perspective this means the current economic system, according to the Third Industrial Revolution, can make it possible to change the economic system, that focuses on the infrastructure of data, energy and goods to become more circular and decentralised (Schouten, 2014). However, such a development has also its downsides, which are related to privacy issues (Martinez-Balleste et al., 2013). If everything is connected to each other and your personal information becomes more 'accessible' then the risks will be that everyone can see and know what you are doing and where you are. In other words, being connected is a good development but your privacy and personal information can be exposed more easily, which can be misused. For this particular reason, the Living Lab concept can be of great value, because it is a form of open innovation in a real life setting in which the daily social dynamics are being included (Almirall et al., 2012).

Building on the Living Lab concepts, these risks can be reduced by taking care of certain topics, just like privacy issues and by involving the users directly at the beginning of the innovation process. It can help to build trust and explore the mutual benefits with your parties to achieve circularity through transparency, openness and the early involvement of users (Bergvall-Kåreborn, Ihlström Eriksson, et al., 2009). This will stimulate multiple parties to cooperate and exchange (confidential) information as long as it supports both mutual interest to achieve a circular system. Living Lab concepts can support the CE concept through sharing knowledge and experiences, and cooperation in order to redesigning the current linear system towards a circular system (Preston, 2012). It is necessary to coordinate and facilitate the process in order to develop solutions that match the needs of the users/clients

successfully in the building sector. The next section (2.2) describes the Living Lab concept and explore the methodologies that are being used that can provide solutions for a circular building sector.

Regulations must also align with the developments in the Dutch Building sector that support and enhance the creativity of companies and stakeholders. The five stages on *'the path to becoming sustainable'* of Nidumolu et al. (2009) can be helpful in thinking about the challenges, issues and competencies that are needed as a company on a strategic level, see Table 1. But as the framework suggests, it is about becoming more sustainable as an existing company and it does not mention start-ups. This framework can be seen as a starting point to develop a method that is applicable for the Dutch building sector and includes the principles of Living Lab methodology and CE to design (circular) businesses that enhance the system transition towards a real circular economy and society.

To make the step to design (circular) businesses Bocken et al. (2015) explored what is needed as a designer or as a business strategist to move a business to a circular economy model. Based on their study they developed a '*Circular Economy Product and Business Model Strategy Framework'* (see Figure 9). Still the challenge is, how this framework can be embedded with essential elements such as supply chain, enabling technologies, and infrastructure (Bocken et al., 2015). Finding the connections with the above essential elements is an area where potential opportunities can be found for new businesses. To find these potential opportunities is to facilitate companies or organisations with their business innovation processes that actively involve the users to understand their needs along the process and respond to fulfil those needs. How to involve the users actively along the process is where Living Lab concepts can play a vital role (Feurstein et al., 2008; Mulder and Stappers, 2009; Schuurman and De Marez, 2009). In what way it can play a vital role for business innovation process in the building sector will be explained in the next section.

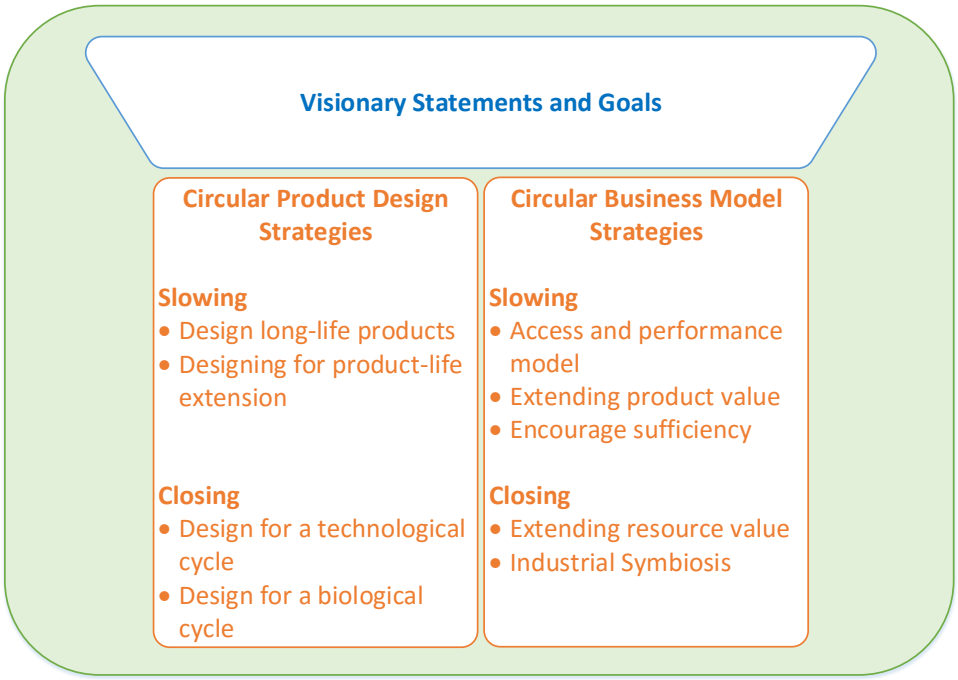


Figure 9: Circular economy product and business model strategy framework (Bocken et al., 2015)

Table 1: Overview of the phases on the path of becoming sustainable with their definitions and structural elements, derived and adapted from Nidumolu et al. (2009).

Phase	Definition	Elements
Viewing compliances as opportunities	The first steps that occurs when companies aim for sustainability are the compliances of a country, region or state in which the company is settled. These compliances should be considered as challenges to meet and anticipate the rules that foster innovation in order to gain the first-mover advantages.	- The ability to anticipate and shape regulations; - Collaboration (including competitors) implement new, innovative or creative solutions; - Use compliance as a system boundary for innovation by experimenting with sustainable technologies, materials, and processes.
Making value chain sustainable	The moment in which companies are familiar with the regulations can focus on making their value chain more efficient by working with suppliers and retailers to develop eco-friendly raw materials and components to reduce waste. Through analysing the linkages within the value chain companies can focus on developing sustainable operations.	- Improve and increase the value chain efficiency; - Making suppliers within the supply chain more environmentally-conscious by offering incentives; - Develop and introduce innovative operations; - Mechanisms that links sustainable initiatives to business results.
Designing sustainable products and services	This stage focuses on offering eco-friendly products and services by (re)designing products through understanding the consumer, their concerns and conscientiously taking the product life cycles into account.	- Generate real added value to support the public with sustainable products or services; - Scaling up both supplies of green materials and the manufacture of products; - Applying techniques such as biomimicry, life cycle assessments, cradle-to-cradle, circular design in the development of products and services.
Developing new business models	In this phase companies rethinking the way their business by finding ways to capture revenue, deliver services and understand the different needs of customers by teaming up with other companies.	- Explore novel ways of delivering and capturing value; - Understand the needs of the customers; - New delivery mechanisms of doing businesses.
Creating next-practice platforms	The final phase is to change existing paradigms by newly developed innovations that can be used as stepping stones for next practices and further developments.	- Questioning the dominant logic behind business today by embedding sustainability; - Building platforms and developing products by sharing knowledge to support follow up steps towards sustainability.

2.2 The Concept of (Urban) Living Labs

Originally the Living Labs concept was created by Professor William Mitchell at MIT. The purpose behind this concept was initially to observe the living patterns of users in a smart/future home for a given period of time. Europe has adopted this concept under the name European Network of Living Labs (ENoLL) and has 340 accredited Living Labs after the 7th wave of new ENoLL members (ENoLL, 2014). This organisation adopted the concept of Living Labs by Professor William Mitchell, but put it in wider use to *"enhance innovation, inclusion, usefulness and usability of ICT and its applications in the society"* (Eriksson et al., 2005: 5).

The core motivation behind this concept is the way in which innovation can be implemented. A distinction can be made between open innovation and closed innovation. In closed innovation is the focus primarily on internal resources that are being used in the company's innovation process (Bergvall-Kåreborn, Ihlström Eriksson, et al., 2009). In contrast, open innovation is defined as using internal and external resources in order to develop the innovation process of a company that result in creating value for customers (Chesbrough, 2006).

Based on the distinction of open and closed innovation, Living Labs extends on the ideas of the open innovation concept. Living Labs' main focus is to use all the external ideas as a resource to support the innovation process in order to develop usable products and services from the user-centric environment (Bergvall-Kåreborn, Ihlström Eriksson, et al., 2009; Leminen et al., 2012; Schaffers et al., 2007). Especially, in built environment the end-user, mostly the client, must be central because they are the ones who are going to use the building according to their needs. To get a better understanding of why Living Labs can be useful for the building sector, a fitting definition is needed to develop the context around it. This makes it clear what the system boundaries are and where to focus on.

The focus is needed because Living Labs can be defined differently according to perspective (see some definitions in Table 2 and the overview provided by Leminen (2013: 8)). The perspective of Living Lab is again based on what the main focus of the research activities and outcome should be in a real-world context. From that respect, the study of Bergvall-Kåreborn et al. (2009) provides three Living Lab perspectives, which are mutually exclusive and collectively exhaustive (MECE), and are categorised by its main focus as:

1. An environment that focuses on technological platforms and user communities;
2. A methodology that focuses on the process of data transfers and tools or methods to involve users;
3. A system that focuses on the relationship between Living Labs as a system and its interdependent parts.

Based on the overview of Leminen (2013), it becomes clear that there is no general definition available for Living Labs and that is why it is important to know which perspective the research will focus on. The focus of this research will be based primarily on the Living Lab as a methodology for involving multiple stakeholders, but considering the aspects of Living Lab as an environment as well. The reason why is, because of the complexity of interaction within a network between different actors that the building sector will encounter during the design & build process, and its impact on environment, economy, and society. Given the definitions in Table 2, some elements can be used that can fit defining a circular building sector: co-creation of innovations by involving multiple stakeholders, including users and producers of the value chain, taking a systems approach, and incorporating the real life context.

Table 2: A list of some definitions of Living Labs used in literature.

Definition	References
A Living Lab is a real-life test and experimentation environment where users and producers co-create innovations. Living Labs have been characterised by the European Commission as Public-Private-People Partnerships (PPPP) for user-driven open innovation.	ENoLL Living Lab (ENoLL, 2014)
A Living Lab is a "functional region" where stakeholders formed a Public-Private-Partnership (PPP) of industries, SMEs, public agencies, universities, institutes and people collaborate for creation, prototyping, validating and testing of new services, products and systems in real-life contexts. Such contexts are cities, villages and rural areas as well as industrial plants.	The European Project CoreLabs (CoreLabs, 2008)
A user-centric research methodology for sensing, prototyping, validating and refining complex solutions in multiple and evolving real life context.	(Eriksson et al., 2005: 4)
An experimentation environment in which technology is given shape in real-life context and in which (end) users are considered co-producers.	(Ballon et al., 2005)
Living Labs are collaborations of public-private-civic partnerships in which stakeholders co-create new products, services, businesses and technologies in real life environments and virtual networks in multi-contextual spheres.	(Feurstein et al., 2008: 2)
A Living Lab is a user-centric innovation milieu built on every-day practice and research, with an approach that facilitates user influence in open and distributed innovation processes engaging all relevant partners in real-life contexts, aiming to create sustainable values.	(Bergvall-Kåreborn, Ihlström Eriksson, et al., 2009: 3)
Experimentation environments; they are physical regions or virtual realities where stakeholders form public-private-people partnerships (4Ps) of firms, public agencies, universities, institutes, and users all collaborating for creation, prototyping, validating, and testing of new technologies services, products and systems in real life.	(Westerlund and Leminen, 2011: 20)

However, in the definitions stated in Table 2, the idea of the Living Lab is still grounded on the fact that companies develop products or services, which are brought into the market to the customers to test and validate it by giving feedback and not co-created by the customers through active participation as in equal partners (Mulder and Stappers, 2009; Mulder, 2012; Sauer, 2013). This also becomes clear in literature where the focus of Living Lab is more related to how IT-infrastructure, ICT and internet can be used as source of open innovation for development (Eriksson et al., 2005; Komninos et al., 2013; Niitamo et al., 2006). It is relevant, but it is only one part of how technology can provide support in open innovation. Additionally, social aspects within current Living Labs are exploratory by nature and are mainly based on creating awareness and testing pilots on larger scale, resulting in valuable knowledge to learn from. In what way learning aspects can be captured in a business model is still lacking, because it gets lost when groups get disbanded or the commercialisation of the developed product or service will be taken care by unrelated companies or organisations (Almirall and Wareham, 2008).

One of the research gaps that needs to be filled is how learning can be captured in business models, without losing it (Almirall and Wareham, 2008). To capture and incorporate learning in a business model it is necessary to understand the solving process of a problem. Solving a problem starts with an initial experiment that is continuously revised, adapted and refined until the problem is solved (Sosna et al., 2010). An initial experiment is not defined as one specific attempt to solve a problem, but can be a repetition of varied attempts that aims for a desired result (Sosna et al., 2010) or in search for an operational process towards 'perfection' (Levitt and March, 1988). It is in fact a learning process in which continuous cycles of improvement are the basis to strive towards an excellent operational process by following, for example, the Deming Cycle (i.e. Plan-Do-Check-Act Cycle) that is inspired by the Japanese *Kaizen* philosophy (i.e. Total Quality Management) (Tissan and Heikkila, 2001). This repetitive way of solving a problem is iterative by nature and is called in literature as 'trial-and-error' learning. The principle is to emphasise the 'experience of doing' that is directly gained through the results of your own actions (Reese, 2011).

Furthermore, a distinction of the trial-and-error learning process can be made between *single loop* and *double loop* learning. These learning loops are based on the efficiency of the process. Single loop learning is focused on doing the task better every time and more efficiently to achieve the desired result and double loop learning is focused on not only doing the task better and more efficient, but as well questioning and assessing the desired results and targets (Argyris, 1999).

Based on the above description and with the main focus of the Living Lab on the methodology and environment a combined definition of Bergvall-Kåreborn et al. (2009) and Westerlund and Leminen (2011) can be developed that fit the building sector:

Living Lab in a building sector is a systematic approach that integrates research and innovation by collaborating with multiple stakeholders (public-private-civic partnerships) to co-create, develop and validate new products, services, businesses and technologies for sustainable value in territorial ecosystems in which the user is actively involved.

Given the above definition the Living Lab is a concrete localised setting for open and collaborative innovations, in which the openness of innovation in value propositions are structured in business models and partnerships to create opportunities for technologies (Chesbrough, 2006). It incorporates elements of public participation and communities for innovation (von Hippel, 2005) and the idea that the users are innovators (Schumacher and Feurstein, 2007b; Thomke and von Hippel, 2002).

2.2.1 SWOT-Analysis

To get a better understanding of what the added values are or what is lacking of the concept of Living Labs a SWOT-analysis can be performed. The analysis will be based on the literature. Therefore, the strengths and opportunities of (Urban) Living Labs are established according to current Living Lab practices and its contribution as method to the landscape of user-centred (open) innovation methodologies. The weaknesses and threats are based on the evaluations of currently achieved Living Labs, like the registered examples of the platform ENoLL, and what can be learned from them (see for example (Eriksson et al., 2005)). Based on this analysis, see Figure 10 and elaborated below, the added value for the building sector and the business opportunities can be explained.

<u>Strengths</u>

- **Active involvement of users:** the innovation process is one of the strong advantages for both the user and the company (Almirall and Wareham, 2008; Boronowsky et al., 2006), because collaboration between user and company markets can be generated (Eriksson et al., 2005);
- **Real-life setting:** is another strong characteristic of Living Labs, because the daily life dynamics of users are included (Almirall and Wareham, 2008; Boronowsky et al., 2006), which give more insight

into the user's social behaviour within a context where they feel comfortable and is applicable on a bigger group (Schuurman and De Marez, 2009);
- **Cost-effective:** because costly changes in further stages of the innovation process can be avoided; also it can generate better ideas and help eliminate irrelevant ideas faster (Schuurman and De Marez, 2009).

Weaknesses
- **Time consuming and high investments costs**: Setting up a Living Lab is a time costly effort process and needs a lot of funding of partners to operate (Almirall and Wareham, 2008; Boronowsky et al., 2006);
- **Drop-out risk before end of test period:** this can be seen as a weakness because without a drive or motivation users can drop-out the test period before it ends. Especially if the Living Lab setting contains a small group of users the risks are higher that the findings of the product or service are not sufficient or robust enough to become successful to made it to the market (Almirall and Wareham, 2008; Schuurman and De Marez, 2009);
- **Lack of clear interpretation:** empirical studies show that Living Lab concepts are still lacking a clear interpretation regarding research parameters, appropriateness of underlying business models and effectiveness of this concept as a system innovation (Eriksson et al., 2005; Schaffers and Kulkki, 2007);
- **Complexity of governing dynamic interactions** on different levels to set system transitions in motion by system innovation (Nevens et al., 2013);
- **Not compatible with better and cheaper solution:** the type of technology is determined if a Living Lab is of use or of no use. In fact, if it can provide a better and cheaper solution with no drawbacks compared to the existing one Living Labs are of no use. Especially, incremental innovations are often not suitable for Living Labs (Almirall and Wareham, 2008).

Opportunities
- **Explore cooperation by sharing experiences:** exploring cooperation between Living Labs by sharing experiences can create more awareness and can positively influence changes in policy innovation (Nevens et al., 2013; Schaffers and Kulkki, 2007). By doing so a new opportunity can occur in which Living Labs can enhance economic, social and cultural systems cross-regionally and cross-nationally (ENoLL, 2014);
- **User's rich knowledge:** within a Living Lab setting, better use of the rich knowledge of the users by feedback, active participation as equal partners, and incorporate this interactions with IT-application or internet can increase the rate of success (Almirall and Wareham, 2008; Eriksson et al., 2005; Schaffers et al., 2007);
- **Embed materialisation and societal involvement:** in the field of urban environment development it is interesting to see how materialisation and societal involvement can be embedded into actual innovation. This should, then, be measured in terms of new products or services start-ups, new product lines, new business or organisational models (Almirall and Wareham, 2008);
- **Capturing knowledge**: this is about the challenge to capture value in an existent business model or a new business model of the gained knowledge by learning and doing (Almirall and Wareham, 2008). Due to the explorative nature of Living Lab concepts the gained knowledge can be categorised as highly contextual that provide valuable information for an interactive exploration instead of information to guide exploration (Almirall and Wareham, 2008).

Threats
- **External financial support**: for the development of Living Labs substantial financial support that is mostly funded externally is needed (Schuurman and De Marez, 2009);

- **Role of users the 'Old fashioned' (reactive) way of innovation:** in practice, most of the time the users in Living Lab have more or less a reactive role that can be seen as the old fashioned way of user-centred approach like in a lab (Mulder and Stappers, 2009; Sauer, 2013). This means if the Living Lab continue on the way of putting emphasis on reactive users it will become just one of many forms of user-centred approach within open innovation.

Figure 10: Summarised SWOT-Analysis of (Urban) Living Lab Concepts

2.2.2 The added value for the building sector

For the Dutch building sector this is an interesting perspective to take a closer look at how this will influence the market, more specifically the urban environment. This have the potential to change the building sector to make it sustainably (Almirall and Wareham, 2008). Urban environments are seen as one of the critical areas to focus on sustainable issues (van Bueren, 2012; Bulkeley et al., 2011) and societal challenges (Baccarne et al., 2014). Such areas can even been seen as potential hotspots for sustainable development (Rotmans et al., 2000) or innovation (Ernstson et al., 2010; Nevens et al., 2013).

This can be achieved by creating a platform or arena in urban areas where people and technology create supply and demand in a real life context by stimulating co-creation and challenging research and development, because multiple stakeholders are part of the innovation process (Bergvall-Kåreborn, Holst, et al., 2009). Especially, urban areas where users are actively involved in the innovation activities to develop certain urban projects have proven to create more adding value (Juujärvi and Pesso, 2013). In this case, companies can develop a competitive advantage by making their value chain transparent and support the users/clients to match and fit their needs by creating adding value for them. This means that users need to be involved as early as possible in the design & build process (Leminen et al., 2012) and let them become innovators to develop new strategies, products and services (Schaffers et al., 2007). This will also build a relationship with your customers

and users in the form of trust and a source of creation (Nevens et al., 2013). Additionally, this will help as well to understand the social dynamics and interactions as a company.

Unfortunately, this is still not fully understood in the literature of the Living Lab methodologies (Mulder, 2012), because most of the Living Lab activities have put their efforts on reactive users (i.e. end-users) by observing participants and ask them for feedback about experience, mismatches and flaws (Hess and Ogonowski, 2010) instead of active users (i.e. equal as partners) during the whole process (Mulder and Stappers, 2009; Sauer, 2013). In fact, it is the 'living' part of Living Lab that really puts the emphasis on participation and co-creation (Mulder and Stappers, 2009) that makes it a great methodology to actively stimulate user-driven and co-creative innovation (Mulder, 2012). Integrating daily life dynamics of the active users and creating space for improvised (i.e. unexpected and unforeseen) ideas, next to a pre-established set of goals, will open up new perspectives and possibilities for innovative ideas and practices that can be seen as more added value creation (Sauer, 2013).

It will be beneficial for companies within the building sector, because the development time and the risk of failure on the market can be reduced (Schaffers et al., 2007). As a company it will become even more beneficial in the long run, because if a company is flexible and can provide tailor made solutions by anticipating the needs within a global market, upscaling will be possible in a short period of time (Leminen et al., 2012). Additionally, actively involve multiple stakeholders and users as equal partners increase their support, build a long term relations and build trust between all the parties (Mulder and Stappers, 2009; Sauer, 2013).

2.2.3 Opportunities for businesses

By opening up your value chain for innovation by co-creating your product and services with multiple stakeholders and users actively during the whole design and build process means as well that a company must share their knowledge with its competitors. It is about setting the boundaries for the involved stakeholders and 'active' users to make clear what their roles are in the whole trajectory. It also makes clear what their influences will be within the entire process on the short-, mid-, and long-run. For companies setting the boundaries and making clear what the roles of multiple parties will be, will help to gain focus on the project and will reveal the opportunities to operate their business.

To embrace the opportunities, boundaries can be set by creating a 'user-need' profile or 'value demand proposition' in the form of visions or ambitions with the users. This way of doing will expose the real needs of the users, in which the company or organisation can act on by providing certain services and/or products, hence, making a value proposition design based on the real needs of the users and match these needs accordingly (Osterwalder et al., 2014). This will trigger a dialogue between multiple stakeholders and the user to co-create. This creates an iterative open innovation process where the parties feel comfortable and are willing to learn and share their ideas to get implemented (Nevens et al., 2013). As a result, it becomes possible to make full use of the knowledge of the users which will become your source of creation. This innovation management process or 'Urban Transition Lab' (UTL) as Nevens et al. (2013) have developed is a good starting point to discover the opportunities and possibilities for (new) businesses by taking into account the visions and ambitions of the users. UTL is according to Nevens et al. (2013: 115) defined as: *'a hybrid, flexible and transdisciplinary platform that provides space and time for learning, reflection and development, of alternative solutions that are not self-evident in a regime context. The platform brings together innovative 'regime' actors and frontrunners from 'nice' context'*.

By comparing the definition of UTL and the developed definition of Living Lab for the building sector (Section 2.2, p. 23), the focus of UTL is on providing an open platform to bring people or multidisciplinary stakeholders together to do experimentations. It is about starting pilots or new

innovative ideas for a specific goal, which are uncertain if it will become mainstream. In the sense of doing experimentations through collaboration, it is about learning, reflecting and developing alternative solutions that fit with the Living Lab definition for the building sector. It explains the process in the manner experimentations in an open setting should be facilitated into concrete action points. This definition is complementary with the developed Living Lab definition for the Building Sector, which is focused on the governance part of Living Labs. However, like all the other definitions it is still focused on explaining the importance of experimentations rather than the execution of these experimentations to let it become mainstream. Nevens et al. (2013) made a start by embedding transition management, but the next step to execution is still missing or is struggling to make proper translations into real practices in the field (Ogonowski et al., 2013).

The focus of UTL is based on cities, because cities are a complex ecosystem in which multiple interactions between multiple actors occur that need to be organised. With the UTL, Nevens et al. (2013) explored the way in which cities can be governed to facilitate a transition process as an open innovation platform for the involved parties towards a more sustainable city. See Table 3 for the phase descriptions of UTL and their elements and Figure 11 for a visualisation of the transition steps and related activities. This concept already highlights the need for an alternative governance structure if cities want to become sustainable (Healey, 2006). It attempts to govern and operate the process accordingly in line with sustainability as a driving force by finding and safeguarding a certain protected 'comfort' zone where uncertainties can be managed (Nevens et al., 2013). Uncertainties that come with sustainability are seen as risky. To deal with them UTL focusses on conceptual, visionary and long-term aspects and try to gain quick wins and visible results/achievements (Guzman et al., 2008; Westerlund and Leminen, 2011), because it cannot fall back on a proven concept or predictable desirable results (Nevens et al., 2013). This also visible by the purpose of UTL to build a framework that mutually reinforcing elements, which varies from envisioning the future (long-term) up to experimenting within a real life setting (Nevens et al., 2013).

Another concept that is coping with the idea of how urban development can become more sustainable and is based on a user-centric approach is Urban Living Labs (ULL) applied within Smart Cities that aim to improve the quality of life in the city (Baccarne et al., 2014). The main idea of Baccarne et al. (2014) is that a Smart City can be seen as a collaborative ecosystem between multiple actors that is represented as a fourfold network (policy, citizens, research and private partners); see Figure 12. From this perspective the role of ULL is to facilitate the interactions between actors oriented on 'urban' or 'civic' innovation (Baccarne et al., 2014; Komninos et al., 2013).

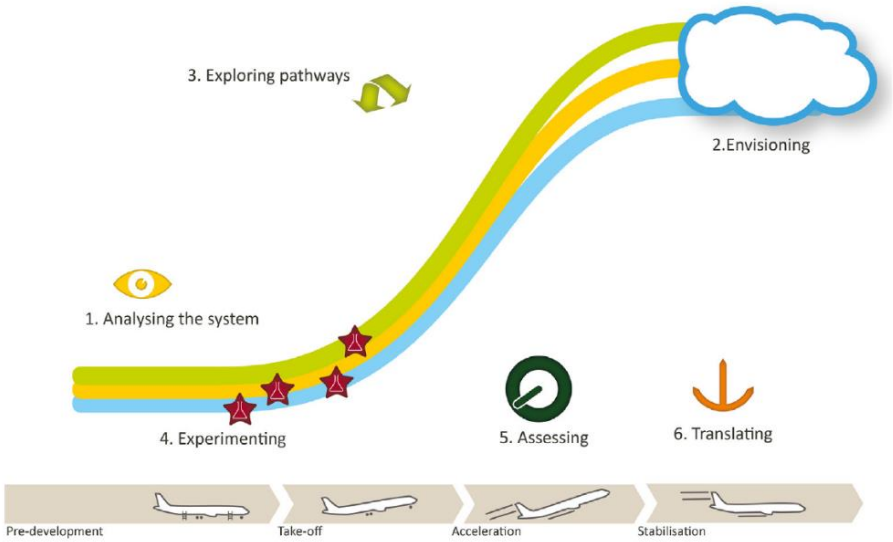


Figure 11: Simplified and logical transition path to sustainable development with the related steps and activities (derived from (Nevens et al., 2013)*)*

The interactions between actors and urban innovation in Figure 12 is represented by arrows as affordance flows and value generation. Hereby, affordance is defined by Baccarne et al. (2014) as *'what one system provides to another system'*. This resembles in the way how Industrial Ecology look to industrial urban ecosystems, in which input equals output. In other words, use and connect different flows (e.g. energy, water, nutrients, waste) within an urban ecosystem together as a symbiosis (Graedel and Allenby, 2010b) that is beneficial. As a result, a region, city or a building will be seen as an integrated, fully ecologically dependent and functioning system in which flows are interacting on different levels. This includes internal relationships, energy and materials flows either as input, output, and internal flows, and that each systems can be part of another system (van Bohemen, 2012).

Within the affordance flows the needs of the actors will become visible as well, because each affordance flow has its purpose to expose the interactions and the way it generates value (Baccarne et al., 2014; Cosgrave and Tryfonas, 2012). Hereby, generated value can be distinguished by two types of value: public values (e.g. societal challenges and/or policy goals) and economic values (e.g. profitability and/or economic growth).

By exposing the interaction between the actors, other dimensions can be evaluated. The essential key dimensions for Smart Cities next to value generation and involvement of stakeholders are the degree of techno-centricity, knowledge reuse, the emphasis on sustainability, and 'future-proofness'.

The analytical dimension techno-centricity and knowledge are important, because it looks at the output results of projects and analyse if the gained knowledge can be reproduced on other projects. In essence, it is about trial-and-error learning in order to increase success of private entrepreneurial initiatives and public projects (Baccarne et al., 2014).

The emphasis on sustainability and 'future-proofness' is also essential, because the way how current Smart Cities are developed are most of time based on strategies that aim for sustainability and material efficiency (Allwood and Cullen, 2012; Baccarne et al., 2014). Therefore, this analysis can help to define and evaluate future Smart Cities and design them accordingly.

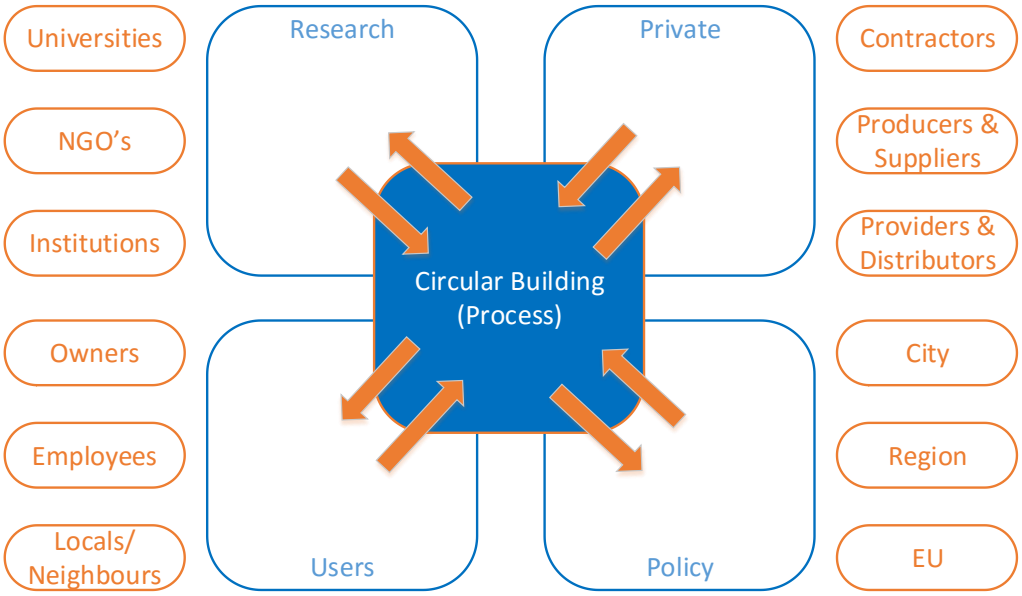


Figure 12: The 'architecture' conceptual model of Smart City: a fourfold network seen as a collaborative ecosystem in which value and affordance flows are interacting between different actors. Derived from Baccarne et al. (2014).

Table 3: Overview of the phases of UTL with their definitions and structural elements, derived and adapted from Nevens et al. (2013).

Phase	Definition	Elements
Setting the context	The pre-phase to create a comfort space where transition action and strategies can be debated that enhances co-creation facilitated by a pre-selected design team without direct involvement of governmental actors that expect usual outcomes, strict timeline, political or other stakes.	- An open environment to stimulate co-creation; - Transition team; - A flexible process design/plan; - Stakeholder management and analysis; - System approach analysis.
Problem structuring and envisioning	A transitions process means facing certain challenges in order to align multiple actor perspectives and visions. This can only be effective if actors are intrinsic motivated to translate these challenges into concrete actions towards the shared goal or vision within their known environment.	- Transition arena, 'playing field'; - Collaboratively problem structuring; - Key priorities; - Guiding principles.
Exploring pathways and building an agenda	This phase can be seen as the first step towards operationalisation of the broader concepts, derived from the shared goal or vision by setting up milestones, doing assessments on feasibility, identifying drivers and stepping stones, and organising relevant collaborations.	- Realisation of key systemic turning points; - Desired and feasible roadmaps; - Objectives and milestones; - Acknowledgement of drivers and barriers pathways; - (Inter) active thematic networks.
Experimenting and implementing	This phase is the operational process in which involvement and collaboration is emphasised, in which the responsibilities are more with the actors 'on the field' to provide the desired and expected outcomes/results.	- Alignment of transition experiments with the set up and the chosen goals and ambitions (pathways) - Linking existing experimental settings/initiatives;' - Setting examples for (innovative) transition processes.
Monitoring and evaluation	This phase is essential when it comes to transition processes, because it is about learning, experiencing and improving current states which can only be done by continuously monitoring and evaluating the structural flow of the process design.	- Adaptation of the chosen strategic pathway; - Adaptation of the generic transition management framework; - Progressing lessons learned; - Sharing and produce knowledge, make it available as well.

Comparing these concepts, both are applying Living Lab aspects to the built environment and aim for the interaction between multiple actors to create possibilities for co-designing the sustainable future with innovative solutions (Baccarne et al., 2014; Feurstein et al., 2008; Mulder and Stappers, 2009; Nevens et al., 2013). Even though these concepts are still needed to be proven in practice, they give guidelines to build on. By stimulating co-designing with multiple actors it is important to understand the needs of the users and the way it can be governed. Therefore, three types of participatory processes are distinguished for a collaborative design process (Bergvall-Kåreborn et al., 2010):

- *Design for Users*: A product and service design approach on behalf of the users;
- *Design with Users*: A product and service design approach co-designed by developers and users;
- *Design by Users*: A product and service design approach where the users assist the developers.

These types of collaborative design processes can be seen, for the building sector, as starting points for a level of transparency of the development and built process. Hereby, the purpose of the product or service in an ULL can then be determined by governing it accordingly. This can be governed either 'Top-Down' or 'Bottom-Up' and engage participants by either 'exhalation dominated' or 'inhalation dominated' (Leminen, 2013).

From the hierarchical perspective top-down governance within a living lab is a way of managing the process that is centralised and have official targets to meet. Therefore, innovation is governed and proceeds from a centralised authority (top) that is delegated to the bottom for the creation, validation and testing of new technologies, products, services, businesses and systems in real-life setting (Budweg et al., 2011; Leminen, 2013). Bottom-up governance is the opposite, where innovations for new technologies, products, services, business and systems in real-life setting are initiated by local needs and ideas from the grassroots level (bottom) that work its way up by the creation of its necessity (Budweg et al., 2011). These needs and ideas are collectively developed, created, prototyped and validated through mutual interest and shared objectives (Leminen, 2013).

The participation approach as Leminen (2013) distinguishes, exhalation dominated and inhalation dominated are based on the way how stakeholders can be engaged for participation in an innovation process. Where 'exhalation dominated' innovation approach (inside-outside approach) is not primarily focused on fulfilling the requirements and needs of the actor that initiates an innovation process, but on the requirements and needs of other stakeholders. This approach engages multiple stakeholders for collective action to commercialise ideas and technologies to the market (Feurstein et al., 2008; Leminen, 2013). 'Inhalation dominated' innovation approach (outside-inside approach), on the other hand, is primarily focused on fulfilling the needs that is initiated by the actor. It aims on engaging the stakeholders to bring them together to use their knowledge, expertise and resources in an open network for innovation activities. It is about initiating innovation through acquisition and collect knowledge externally for a company and fulfilling their specific requirements and needs (Leminen, 2013; Lievens et al., 2011).

Given the two dimensions Leminen (2013) developed a matrix framework (see Figure 13) to understand the innovation mechanism in Living Lab networks, including the four actor roles (Leminen et al., 2012):

- *User*: are user communities that start or use living labs to solve everyday-life problems.
- *Utiliser*: are the companies that start or use living labs to develop and test their products and services for their businesses.
- *Provider*: are various organisations such as educational institutes, universities or consultants that act, mostly, as a collective group to start or use living labs to promote research and theory development, knowledge creation and find solutions to specific problems.
- *Enabler*: are various public-sector actors, non-governmental organisations and financiers that start or use living labs for societal and regional improvements.

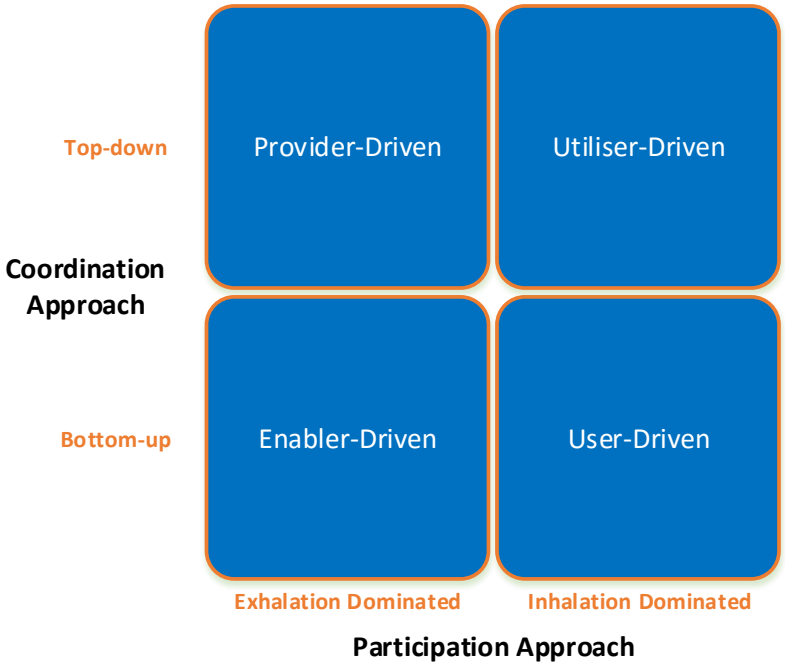


Figure 13: Matrix of Innovation Mechanisms in Living Lab Networks (Leminen, 2013).

The matrix framework identifies and analyses the distinctions between the four different types of living labs that is based on 1) the role of the initiator (the actor that leads the living lab and the innovation activities), 2) the way innovation activities are coordinated and 3) the way participation occurs within then network (Leminen, 2013):

- *Provider-Driven*: innovation mechanism that offers certain solutions and needs to actors;
- *Enabler-Driven*: innovation mechanism that offers activities to serve and improve living conditions of actors in a certain area or region;
- *Utiliser-Driven*: innovation mechanism that develops and creates new ideas, concepts, or prototypes or to validate and test concepts, products and services;
- *User-Driven*: innovation mechanism that develops needs from individuals or communities aims on improvements for the users' everyday life conditions or activities.

Additionally, it is also possible to coordinate process according to a 'Middle-Out' approach. This approach is focusing on the potential roles for experts and users to create societal changes by connecting top and bottom in several direction (i.e. upstream, downstream, and sideways, see Figure 14) to make adjustments throughout the process more flexible (Janda and Parag, 2013). Due to this flexibility it can steer the process when an unfavourable event occurs (e.g. delays, technical errors, unexpected costs, etc.) when necessarily. Therefore, all the actors within the process will be granted with some responsibilities to oversee unfavourable events by acting accordingly.

The responsibilities given to the experts from a middle-out approach, can be used to steer the influences within a process accordingly to its context, this is bidirectional and can be either positive or negative. With this respect Janda and Parag (2013) introduced three modes of influences:

1. Enabling or disabling: an actor is allowed to adopt or promote a strategy to be used in a project whatever the given setting is;
2. Mediating: an actor that adopts a technology, strategy or process and adapt it in order to fit the given setting;
3. Aggregating: an actor that recognises and act upon certain patterns during the designing and building trajectory based on their work experiences.

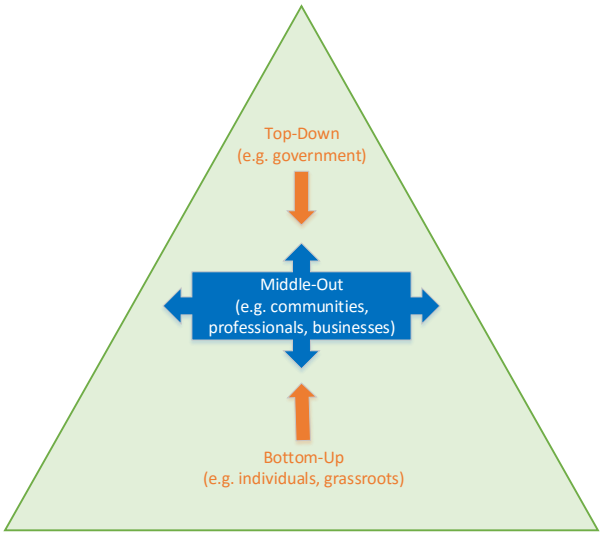


Figure 14: Middle-out approach and its directions of influence (Janda and Parag, 2013: 43)

To govern the development process of sustainable urban areas is quite complex to understand clearly, because of the social and dynamic interactions between different levels of actors (e.g. stakeholders, users, experts, policy, etc.). This makes it challenging to find sustainable opportunities to solutions that benefits all (Seto et al., 2010). In that respect, a lot of potential possibilities for (new) businesses can be found, however, the challenges are: where and how to find them, capture the values of individuals or multiple actors in business models (Almirall and Wareham, 2008; Feurstein et al., 2008; Niitamo et al., 2006) and simultaneously make businesses future proof (Chesbrough, 2010; Niitamo et al., 2006).

To find the possibilities as a business in a complex and dynamic system like the urban environment is to ask the question where your business can start to maximise its impact on the whole system positively. It is about setting the boundaries, creating social value and inspiring capacity (Baccarne et al., 2014) in order to achieve the higher goal: a sustainable urban environment. An urban environment can be considered as an ecosystem, where each system within the system can be dealt with. Starting from buildings as (eco)systems decisions made on this level can influence other levels on a spatial scale either positive or negative (van Bueren, 2012). In fact, the level of impact can be maximised because users/clients can participate more actively and intensively due to the familiar settings. As a result, businesses can adopt the rich experiences and social dynamics of everyday life of the users and get tangible results. This is enhancing open innovation, co-creation and active participation between multiple parties (Mulder and Stappers, 2009). To adapt such an approach successfully it will have its consequences on the supply/value chain, and the internal and external structure of the company (Nidumolu et al., 2009).

The main opportunity for businesses is to look for practical solutions. These solutions should integrate and capture the value of co-creation, let users/clients participate to pursue multiple sustainable goals (social, economic, environmental), and learn from experiences (Nevens et al., 2013). Like in UTL and ULL they make use of already gained knowledge within a collaborative ecosystem and stimulate future proof innovation to boost the economy and improve the quality of life in the built environment (Baccarne et al., 2014; Nevens et al., 2013). In other words, a paradigm shift towards a collaborative ecosystem is needed. The focus on how shared value (Porter and Kramer, 2011) can be created has the potential to initiate a paradigm shift. Shared value is a concept that is defined by Porter and Kramer (2011: 63) as: '*policies and operating practices that enhance the competitiveness of a company while simultaneously advancing the economic and social conditions in the communities in which it operates. Shared value creation focuses on identifying and expanding the connections between societal and economic progress*.'

The way Porter and Kramer (2011) define shared value is still focused on the pure business perspective and not on the user or stakeholders where a Living Lab concept excels in. For this particular reason the concept of CE can be of added value for ULL to integrate shared value. In this case the principles of ULL and CE will extend the definition of shared value. Thus, the concept of circular shared value fits better in which it embeds value creation by public/social value, economic value and environmental value. Public value can be referred to the value that is created by creating and implementing services and technologies that sufficiently exploit opportunities within the city, face and overcome societal challenges, and/or realise policy goals (Cosgrave and Tryfonas, 2012). Economic value refer to the creation of revenue streams and economic instruments, for example, annual economic growth of cities and companies within the city, decreasing unemployment, generating new business (start-ups) that are able to survive, reducing bankruptcies, increasing competitive advantages, and attracting existing businesses to the city (Baccarne et al., 2014). Circular refers to adapting the principles of CE.

As mentioned earlier, one of the opportunities for businesses is the creation of value by emphasising the involvement of stakeholders intensively during the design and build process. It is important to think in systems that support stakeholders and use their knowledge to generate solutions. Within this aspect it means that a company needs to think in performance based solutions which again can be realised by involving the stakeholders as early as possible during the development of products and services (Feurstein et al., 2008). From this point of view UTL or ULL methodology can support this process and incorporate the creation of circular shared value.

At the building level the opportunities that occur for business is mapping the user/client needs and patterns in a profile or value proposition design. It will become clear what really is needed and provide companies deeper insight to act on it (Mulder and Stappers, 2009) if the given input is being used equally with the input of an expert (Sauer, 2013). This also means to be open minded for co-creation by sharing and collaborating, even with competitors, in an open innovation process. As a result, it will be easier to find, invent and improve value proposition of the users that can be translated into a profitable business that need to be (re)developed (Bocken et al., 2013; Osterwalder et al., 2014). This is exactly in which Living Lab concepts can be used in the building sector. By involving the users and relevant stakeholders, their knowledge and needs at the beginning of the supply chain, the building sector will become more transparent and can be tailor made according to the needs of the user. This will result in the creation of economic, environmental and social added value by developing better products and services and (re)developing profitable (new) circular business models in order to gain a competitive advantage.

2.3 (Circular) Business Model (Innovation)

A business model is the fundamental aspect and driving process of a company. In fact business models are developed to create value for all the stakeholders that are involved with and in the company (Zott and Amit, 2010). Circular Business Model Innovation is to change one or multiple components of business models by developing new ways to create, deliver and capture value in order to close loops (Mentink, 2014).

In CE this means companies need to rethink their business models. In theory, rethinking or developing business model is not complicated, because it takes everything into account that is important for the company's business model, like core business activities, key partners, target groups, distribution channels, cost structures and revenue streams (Osterwalder and Pigneur, 2010). It deals with the creation of value propositions that customers accept and pay for (Bakker et al., 2014). If a company focus on designing products that last as starting point, which contributes to sustainable value and reduce material flows, any business model could be applied to serve these products (Bakker et al., 2014). In practice this is not the case, because the consumers are still buying products that are meant to have a 'deadline' by becoming obsolete and need to be 'replaced' (Bakker et al., 2014).

To change this mind-set in business models it means that companies need to think differently to generate revenue. Sales transaction must not be the only driving force for producers to make products, because then they will lose their interest in their own products and a business-as-usual scenario will continue. For the continuity and survival on the long-run, a business model must look beyond generating economic value for customers and shareholders. It is also about creating value in the form of well-being, improvement and preservation of humans, companies, the society, and the environment in a way that does not compromise inter-generational equity (Rana et al., 2014). In that respect a business model, ideally, becomes 'real' sustainable. According to Rana et al. (2014: 13) sustainable business models are defined as: "*Sustainable business models seek to go beyond generating economic value primarily for customers and shareholders, but try to create social environmental and economic value for a broader set of stakeholders in the industrial network. As such, a sustainable business model is the holistic value logic that encompasses economic, environmental and social goals while aligning the interests of all stakeholder groups.*"

The definition makes it clear that sustainable business models must include creation of economic value (e.g. profit, growth and financial resilience), environmental value (e.g. guarantee complete regeneration and renewal of resources, zero emissions and preserve biodiversity), and social value (e.g. poverty, community development, equality, health, safety, and secure and meaningful employment) (Rana et al., 2014).

If the focus of the producers will be on circular business model innovations to keep the wheel turning, the producer can think about getting more benefit from every turn taken (Bakker et al., 2014) by embedding the characteristics of sustainable business models (Rana et al., 2014) and creating shared value (Porter and Kramer, 2011). Therefore, the Circular Toolkit, as an example, can be a useful tool to find information and opportunities to start with (Evans and Bocken, 2015) and to look up the business model innovation grid that categorised eight business model archetypes (Bocken, Short et al., 2014).

For companies that want to become more 'circular', more involvement in the design, usage and disposal phase of products for innovation is needed to generate value/revenue streams and positively influence technological/environmental, social and organisational benefits (Bakker et al., 2014; Bocken et al., 2015; Bocken, Short et al., 2014). There are possibilities to develop more circular business models if waste can be turned into valuable products or resources, for example, Cradle-to-Cradle (Section 2.1) or Industrial Symbiosis, or delivering functionality rather than ownership, for example, PSS.

For creating value from waste, Cradle-to-Cradle emphasise on the principle 'design waste out' (McDonough and Braungart, 2010). Industrial Symbiosis emphasise on physical exchanges of materials, energy, water and by-products in a cluster/region (Chertow, 2007). These exchanges are process solutions in which a waste stream from one process is turned as feedstock for another production process (Chertow, 2007; Graedel and Allenby, 2010a).

For delivering functionality rather than ownership, PSS is a model where the service for a physical product becomes important instead of selling it and the performance of the product is to optimise the entire value chain (Accenture, 2014; Tukker, 2013). The general problem with PSS is that there is no clear strategy or approach that convinces customers to use products as a service over ownership by buying products (Allwood, 2014). Although, a collaboration of Philips and Turntoo with their pay-per-lux business model have already provided an interesting business case that a PSS model is beneficial for both the company and the customers (Ellen MacArthur Foundation, 2011).

According to Accenture (2014), if companies are adopting circular economy principles in their business activities and models they can achieve a real competitive advantage. The reason why they can gain

more advantage is because of thinking ahead of their competitors by innovation for both resource efficiency and customer value that can be integrated throughout the whole company's strategy, technology and operations (Accenture, 2014).

By thinking ahead of the competitors and being advantageous another approach is needed that incorporates adding value creation into business models. In practice the existing tools or business models only focus in general on one dimension of sustainability, for example, on the environment or on economic value. As a result, these tools and business models fail to take a systems approach to incorporate all dimensions of sustainability in its planning process and its validation is limited (Bocken et al., 2013). This means if you want to develop business models, which improve the economy towards circularity and make social changes, a holistic approach is needed (Bocken, Short et al., 2014; Porter and Kramer, 2011; Rana et al., 2014) and a broader view by looking for existing business cases beyond your sector to gain insights (Bocken et al., 2013).

Having a broader view and a holistic approach does not mean only generating economic value, but as well generating environmental and social values that benefit the company, stakeholders and society (Lüdeke- Freund, 2010) and creates sustainable business cases (Bocken et al., 2013). Bocken et al. (2014) created an overview that distinguished eight archetypes of sustainable business models (i.e. business model innovation grid) that provide companies or organisation opportunities and pathways to make their business future proof. It is important to get clear insight on the value propositions of stakeholders, customers and firms that are required to clarify the benefits and costs when a sustainable business is going to be created (Bocken et al., 2013).

The value proposition is based on the creation of circular shared value that includes the triple-bottom-line (i.e. public/social value, economic value and circular/environmental value) and must be done by involving multiple stakeholders to create a shared language (Osterwalder et al., 2014). This can be helpful to (re)organise or (re)structure the companies in order to find novel ways to deliver and capture value that influence business models (Nidumolu et al., 2009). Which stakeholders or actors are needed to include their value proposition can be mapped out by the value mapping tool (Bocken et al., 2013). By combing both concepts CE and Living Lab to enhance circular business models, the whole value chain needs to be reorganised (Porter and Kramer, 2011) and circularity needs to be the goal to achieve competitive advantages (Nidumolu et al., 2009).

For the Dutch Building sector, the value propositions of stakeholders and users/clients are potential key aspects that can create a circular business model. Especially, in this sector there are many contractors and suppliers that make it difficult to find the right parties to collaborate. It is because of a highly competitive market for every contractor in their field of expertise (OPAi and MVO-NL, 2014). This makes it complex to find the right contractor or supplier who is willing to align with a certain (circular) project vision.

The current economic mechanism that drives the building market are tenders that are put on the market. Most of the times the key decision is still made by the method of procurement in which the lowest price is decisive and not the lifespan and its expenses (Schouten, 2014). This makes it necessary to move towards a circular economy, because if the procurement is still focused on the lowest price, the risk that a business-as-usual scenario will be maintained increases and will affect the depletion rate of the resources negatively (Allwood et al., 2011; Ellen MacArthur Foundation, 2012). This scenario can be avoided if the mind-set based on the lowest prices changes into a mind-set in which the economic, social and environmental benefits are affordable at the best price.

To change the above mind-set, cooperating with multiple stakeholders and users/clients to define their value proposition becomes necessary. By defining the value proposition, it is about creating, delivering, capturing and exchanging economic, social and environmental values (Lehmann et al., 2015) and

stimulate circular business model innovations to match it. For an example see Sosna et al. (2010) who used the trial-and-error learning in a real life setting to stimulate business model innovation. This suggests that a company is in a continuously learning process to refine and improve its business.

Additionally, a relatively new concept called “Lean Start-Up” also emphasises the learning aspect to continuously refine and improve the business model by testing hypotheses (Blank, 2013). This Lean Start-Up methodology focuses on gaining frequent customer feedback as early as possible by showing “minimum viable products”. This way of experimenting creates feedback loops with the customers during product development cycles (Maurya, 2012), which makes it an iterative product design (Blank, 2013) and results in developing user-centred solutions by adapting the needs of the customers that fit the core business assumptions (Mueller and Thoring, 2012). It is about getting quick gains and results, but failing several times as well, which helps refine the business model until the business hypotheses are proven to start the execution (Blank, 2013), see also Figure 15.

For the building sector this will not differ, however, for circular buildings, an extra dimensions need to be taken into account, which are the different lifecycles within a building. A building can be divided in six shearing layers called the 6S-Model: social, stuff, space, service, skin, structure, and site (Brand, 1994). It is about which part or layer needs to be look at. For example, looking at the structure of a building, which can last for centuries, has a different lifecycle then the interiors (e.g. walls, ceiling, doors) of the building, which can last for decades. In other words, each part of the building can have its own business model that fits its purpose, but it also needs to fit the whole system. Knowing how these different layers can be connected, new innovative ideas and business models can be created and can be taken into account in the integral and co-creative circular building design process.

In this respect, developing a practical facilitating tool for the Dutch building sector that takes into account multiple stakeholders, the six shearing layers, creation of circular shared value, reorganising the supply/value chain can be useful. Combining CE and Living Lab methodology in a practical tool to enhance businesses to rethink their business modelling process can contribute to speed up the system transition towards a circular economy and society.

As a result, innovation for circularity will become the driver to develop better products and services with a corresponding circular business model. Nonetheless, if a circular business model is created, this does not mean the end of it. Continuous refinement and improvement for circular businesses (Porter and Kramer, 2011; Stubbs and Cocklin, 2008) is also essential to upkeep the quality and make your business resilient for changing dynamics (e.g. technological trends, social trends) in the market. This also means its viability and robustness must continuously be validated externally and internally (Zott and Amit, 2010). Circular business model innovation can be of great support to use its iterative characteristics for a systematic and on-going creation of business cases for circularity (Schaltegger et al., 2012).

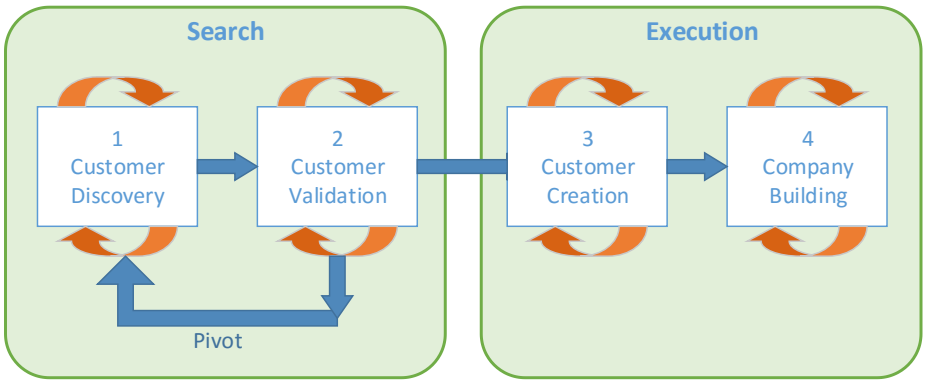


Figure 15: Lean Start-Up methodology [derived from (Blank, 2013: 6)*].*

2.3.1 SWOT-Analysis

The main characteristic of (circular) business model innovation is a method that support the business modelling process by capture value of different stakeholders in order to preserve the survivability of your business.

To get a better understanding and valuable insights what the added values are or what is lacking from the concept of (circular) business model innovation, a SWOT-analysis can be performed, which is summarised in Figure 16. The strengths and opportunities are established according to the idea that companies need to commercialise new ideas and technologies to stay competitive in the market to do their business. Companies do sometimes underestimate the business modelling process and its relationship between products or services, which can be conflicting with existing assets. The conflicts that may occur will present the barriers, hence, the revealing of weaknesses and threats.

A good business models make good business, but a good technology does not make a good business model or what Chesbrough (2010: 354) stated: *"A mediocre technology pursued within a great business model may be more valuable that a great technology exploited via a mediocre business model."*

Strengths

- **Systematic and on-going creation of business cases:** due to its iterative process (Schaltegger et al., 2012) it can support decision-making by guidelines or set of rules for entrepreneurs and employees by taking the value proposition of the stakeholder as a given (Morris et al., 2005);
- **Holistic/Systems approach:** due to a holistic approach business models become a powerful tool to analyse, test, validate and communicate your strategic choices (Shafer et al., 2005). It captures and creates system wide value for all stakeholders and for the company or organisation itself (Sosna et al., 2010);
- **Value proposition oriented:** (circular) business model innovation supports the business modelling according to value propositions. In fact, each business model can be seen as unique and difficult to replicate, because business models are being developed in order to meet particular customer needs (Teece, 2010).

Weaknesses

- **Lack of a common source of information:** for researches and practitioners it will become difficult to get an overview of the scope of business model innovation for sustainability, because they are constrained to exploit their full potential and its usage practical and scientific (Bocken, Short et al., 2014);
- **Reliant of well-trained (external) facilitators:** in practice to emphasise a holistic approach and facilitate the process it still relies on well-trained (external) facilitators (Bocken et al., 2013);
- Lack of creating possibilities for transparency and space for experimentation (see for e.g. trial-and-error learning (Sosna et al., 2010)), due to **conflicts** between already established business models and new business models for existing technology, underlying **configuration of assets** and **resistance** of managers (Chesbrough, 2010).

Opportunities

- **Experiment and explore new markets:** commitment to experimentation by taking active tests and exploring markets with new potential configurations of the elements of a business model, which again provide new insights and data to learn from it and get ahead of the rest of the market (Chesbrough, 2010);
- **Trial-and-error learning:** allowing more experimentation in business modelling the organisational process (and these are not mapped in currently available tools (Chesbrough, 2010)) need to change to encourage and support trial-and-error learning. This can be achieved by sharing knowledge as much as possible (Chesbrough, 2010; Sosna et al., 2010);

- **Identifying internal leaders to change business models:** to overcome the 'trap' of earlier business models, and regain new growth and profits, business model innovations is needed to stay competitive. Therefore, an organisation needs to identify their internal leaders that can manage the results of the business model innovation processes to turn it into new business model for the company (Chesbrough, 2010). Simultaneously, the organisation's culture also need to be prepared to slowly embrace the new business model, while maintaining the effectiveness of the current business model until it can be taken over completely (Chesbrough, 2010).

Threats

Shafer et al. (2005) have highlighted four common problems of business models that is associated with their creation and use:

- **Flawed or untested assumptions**: it is vital for a business model to make well-grounded argumentations to explain the implicit and explicit cause-and-effect relationships (Shafer et al., 2005);
- **Incompleteness**: when developing a business model, it is important as a company or organisation to address all its core logic for creating and capturing value, and not only part of it;
- **Misunderstanding the relationship between value creation and capturing**: if a business model strategy of a company or organisation is leaning too much on the creation of value, it might lose sight on the part to capture value. Losing sight of capturing value will result into a situation in which a company or organisation is unable to capture corresponding economic returns.
- **Fixed existing value network**: flawed assumption in which business models are built that fits the current network, but do not take potential future developments into account will end up in a locked-in business models. This situation makes it difficult to change the business model and ultimately leads a company or organisation towards its bankruptcy.

Figure 16: Summarised SWOT-Analysis of (Circular) Business Model (Innovation)

2.4 Building Blocks for a Circular Building Process

When emphasising a system change towards circularity, the whole life cycle process of products and services needs to be taken into account to do business in CE. By putting emphasis on life cycle or circular thinking the first thing that can make an impact is to look for circular design strategies in which material flows are essential for its circular and profitable viability as a business (Bakker et al., 2014; Bocken et al., 2015). CE provides the opportunities to reduce material flows by aiming for products that last that have its effect on the way in which products or services will be used with the associated responsibilities. This corresponds with the development that the paradigm shift will change to service or performance based models instead of product based models (Schouten, 2014; Tukker, 2013).

For the building sector managing the resources efficiently and aiming for products that are based on services or performances open up new business opportunities. As an example, the shift to see buildings more as resource depots or material banks will change the market mechanism in which resources get other (economic) values (Schouten, 2014).

Building a relationship with the users by understanding their needs is essential too for the success of CE (Su et al., 2013). It is valuable to actively involve the users as equal partners together with other stakeholders in the development process throughout the supply/value chain (Bakker et al., 2014; Bocken et al., 2013; Ellen MacArthur Foundation, 2012; World Economic Forum, 2014). By knowing the needs of the users, companies can align their supply/value chain by collaborating with multiple stakeholders to develop solutions that are tailor made and match the user's needs.

To facilitate the involvement of users as equal partners with other stakeholders it is essential to develop a CE in the building sector. The focus of cooperation is still on making material flow more efficient with related stakeholders. For the business cooperation within a supply/value chain this is based on the company's core business product (for example concrete, asphalt, and aluminium). Thus, in order to involve users and multiple stakeholders their expertise, cooperation through the whole supply/value chain is needed (Ellen MacArthur Foundation, 2012; Yuan et al., 2006).

For the building sector the challenge, then, is to manage and facilitate the intensively collaboration between key stakeholders and users (Baccarne et al., 2014; Nevens et al., 2013; Romero and Flores, 2009) in which the total package will be delivered that serves all the needed functionalities, performances and experiences given the building assignment. Thus, to handle these circumstances and face the challenges for a circular future, a holistic approach is necessary in order to align the environmental, economic and social changes.

Aligning the current system to a circular system, the aspects stated by Bocken et al. (2014) need to be covered: encourage minimising of consumption, maximise economic, societal and environmental benefits, develop products based on functionality and experience, encourage the use of human creativity and skills, and healthy and transparent competition. (Urban) Living Lab principles for active involvement and integration of multiple stakeholders and users are complementary to the system (Baccarne et al., 2014; Nevens et al., 2013; Schumacher and Feurstein, 2007a).

By comparing both concepts, it is about creating added value by innovation and system thinking in order to develop new business models. To add value, it is important, as mentioned before, to get a clear picture of what the needs or the value propositions of the user and stakeholders are to make the business model beneficial, i.e. ecological, economic, and social & cultural, by creating a situation that benefits the parties (Bocken et al., 2013; Edwards-Schachter et al., 2012; Osterwalder et al., 2014). The Lean Start-Up methodology argues that getting a clear picture of the needs can be achieved by experimenting with business hypotheses, test these with the stakeholders and users, get feedback and eliminate wasted time and resources during the product development (Blank, 2013). This is an iterative

and incremental process to create minimum viable products by listening to the users or customers before it will be executed as proven to be scaled up into business (Blank, 2013).

Building on the mentioned aspects, constructing buildings can be seen as an (eco)system facilitated by a building process. However, to define a building process, it is important to make clear what the driving process of the building (eco)system or building context will be. As discussed in Section 2.1.3, three general building principles were distinguished; 1) design from sketch, 2) renovating and retrofitting and 3) demolition.

Designing from sketch is preferable from a circular perspective because, the whole building can be designed based on the latest technologies and innovations. Some examples are the Edge[4] at the South-Axis Amsterdam, Park 20|20[5] at Hoofddorp and the new City Hall Venlo[6]. The most challenging is, however, renovating or retrofitting existing buildings, because of the need of continuous maintenance, upgrades, adaptation and rehabilitation. The demolition of buildings is another category that need to be taken into account from a holistic approach and environmental impact. Not only during demolition material (waste) flows occur, even during the renovation processes lots of material (waste) flows are becoming visible (Icibaci and Haas, 2012). This need to be solved appropriately in order to make the built environment circular, see for examples the projects done by the Dutch demolition company Oranje BV[7] such as Heijplaat Rotterdam and Overtoomseveld Amsterdam.

For the circular building process, however, only the first two general building principles will be used to distinguish and to set the boundaries for the process. It is assumed that circular buildings do not generate 'waste' during construction, renovation and after its usage, thus demolition is seen as an integrated part of the building design strategy in order to close loops, to create multiple adding value and to become resource efficient (EEA, 2015; Ellen MacArthur Foundation, 2012; McDonough and Braungart, 2010; Schouten, 2014).

To facilitate the circular building process, the whole process can, in general, be seen as the traditional building process, but approached differently. The building process can roughly be divided in three processes: design phase (tendering and designing), construction phase (execution) and operation & maintenance phase (see also Figure 7 in Section 2.1.3). These processes can again be linked to the main activities of Living Labs which are co-creation, exploration, experimentation and evaluation (Westerlund and Leminen, 2011). However, the differences between a circular and traditional building process are the way the process starts and the change of the responsibilities for the operation & maintenance phase. For a circular building process, it starts a tendering that is based on the functional performance needs of an actor (policy, private party, research institute, and user) and not based on the technical requirements of the owner. The actor will be also the initiator of the project and will start the tendering procedure by setting the conditions for the circular building process and the businesses that will be developed (Schaffers et al., 2007). For the latter, the producer or supplier stays the responsible owner of the used building materials and products and not the user/owner of the building.

When the conditions are set after the tendering, the design process will start. During this process stakeholders and users will be stimulated to think in possibilities and opportunities to satisfy the set conditions. Linking this back to the main activities of Living Labs this means an iterative process will be set in motion through co-creation, exploration and experimentation between the stakeholders and users. The design phase in this sense is then about co-creation, exploration and experimentation. Co-

[4] World's most sustainable building, BREEAM-certified as 'Outstanding' with a score of 98.36% (http://www.the-edge.nl/)
[5] First full service cradle to cradle working environment in the Netherlands (http://www.park2020.com/)
[6] The city of Venlo in the Netherlands is building a new City Hall based on the principles of cradle to cradle that is designed according to a vision instead of a detailed design. The Dutch Kraaijvanger Architects have won the European Tender process by this innovative approach (http://www.c2c-centre.com/project/venlo-city-hall).
[7] http://www.oranje-bv.nl/

creation can be defined as an activity where all the relevant actors are co-designing a product and exploration as an activity that explore the needs, behaviour and opportunities (Westerlund and Leminen, 2011). Experimentation in the design phase is the activity to implement scenarios to fit the conditions (Westerlund and Leminen, 2011) or can be defined as an operational process in which the stakeholders are responsible for the expected and desired outcomes/results (Nevens et al., 2013). This also suggests that an active iterative process occurs during the design phase that needs to be monitored on regularly basis if they still are aligned with the set conditions or shared future vision.

By merging these three activities will support the idea in what way a circular building with Living Lab elements should be designed. Therefore, ULL and UTL are useful concepts to understand ecosystems within the built environment and in the way how actors interact with each other during the whole building development trajectory (Baccarne et al., 2014; Nevens et al., 2013). This includes the tendering, designing and experimenting activities of the building process. By involving the users and stakeholders at the beginning of the value chain with a clear (circular) vision and ambitions, the whole trajectory can become more transparent and flexible for tailor made decisions that fits the needs of the users.

As described earlier, ULL according to Baccarne et al. (2014) is a collaborative ecosystem that can be used to analyse the involvement through affordance flows and value creation of multiple actor within an ecosystem. By mapping these affordances, the interactions between actors can be analysed. It also helps to identify the stakeholders and users.

Where ULL's main focus is on the analysis of the interactions between multiple stakeholders and users, UTL of Nevens et al. (2013) is more focused on the procedure how to govern the development process by going through five structural elements or phases: 1) Setting the stage, 2) Problem structuring and envisioning, 3) Exploring pathways and building an agenda, 4) Experimenting and implementing, and 5) Monitoring and evaluation. In other words, it focuses on the governance process towards sustainable ways of future development and simultaneously wants to deal with societal dynamics to make a change in the current system (Nevens et al., 2013).

It is evident that ULL and UTL are useful concepts to understand the importance of co-creation and experimentation during the design phase, but it does not explain what will happen next in the construction phase or execution phase. For circular buildings this phase should be included in order to create business cases, because people tend to change or will be convinced when visible results or quick wins are presented (Nevens et al., 2013). This is also what the Lean Start-Up methodology want to encourage, search for working solutions and products that fits the context of the demanding needs. It is about gaining quick wins with a circular idea/solution by going from failure to failure, learning from them and adapting through refinements or adjustments until it is proven to be refined enough to start the execution phase (Blank, 2013). In the end, when the construction is completed an evaluation of the project will take place. This will assess the process and generate lessons learned to build further on for the next circular project.

For the more business perspective the research of Nidomulu et al. (2009) can be complementary to the structure elements of UTL. The focus of this framework is based on the needed challenges, competences, and opportunities for a company to strive for sustainability. Thus, the framework of '*the path of becoming sustainable*' is more specific on companies itself how they can restructure their business to strive for ambitious goals related to circularity.

Nonetheless, these two frameworks' main achievement is to help businesses to be prepared for the future. By combining both frameworks, more transparency can be created throughout the whole tendering and development process of circular buildings. This means it opens up doors for new possibilities for new strategies that are more resilient for future practices, because being open can be

a powerful advantage to create and capture value from creative individuals, innovation communities, and collaborative initiatives (Chesbrough and Appleyard, 2007).

For understanding the possibilities of new strategies the '*Circular economy product and business model strategy framework'* of Bocken et al. (2015) can be useful to help to define business strategies. By defining business strategies, especially in the building sector, it may be useful to understand the needs of the actors. Based on the needs, a business can decide how to coordinate and approach the circular building process. This decision will generate different outcomes, therefore, the *'Matrix of Innovation Mechanisms'* of Leminen (2013) (and may be extended with the middle-out approach) can be a useful framework to analyse these results and give arguments why the selected innovation mechanism was applicable or not for a certain case or project. The framework enables actors to open up their innovation developments to a preferable extent within open innovation communities. The preferable extent can be decided by letting business opportunities to focus on a variety of approaches for coordination and participation within different open innovation processes or networks (Leminen, 2013), hence, the opportunities to create circular shared value.

By combining CE, ULL, and UTL, a systematic and user-centric facilitation tool can be developed that is focused on creation of circular shared value, and an iterative collaboration between multiple stakeholders in order to design and construct/execute a circular building, see Table 4 for an overview of tools and methods that is going to be used. This should result into (new) circular businesses that really match the needs of the users and can help to make the first step in the transition towards circular economy in the Dutch building sector.

To summarise a way of doing business in circular building process it is about collaboration and co-creation with multiple actors from a user-centred approach, but also taking in mind that it is about making future proof businesses. This means a change of mind-set to circular businesses is needed. To change this mind-set and transition towards circularity in the building sector, a standardised facilitation tool inspired by the concepts of ULL and UTL will be developed. This tool facilitates and stimulates a user-oriented community, to map out the user and stakeholders needs in an integral and co-creative circular building process. Within this community the needs of the user and stakeholder as input should stimulate collaboration between multiple stakeholders in order to propose circular solutions that will match those needs. When the match is found a convenient circular business model must be provided that ultimately creates a situation that benefits all the parties. Collaboration is one of the key component for success because as stated by Edwards-Schachter et al. (2012: 682): *"Successful collaboration may result in improved processes or services and new business models together with "social inventions" (rules, procedures, programs, norms) that can be replicated (with sociocultural adaptations) to improve overall quality of life and the socioeconomic conditions in participating communities."*

Table 4: Summarised overview of the main frameworks and complementary frameworks/concepts that will be used in this research to develop a facilitation tool for a circular building process.

Main frameworks for development facilitation tool	**Urban Transition Labs (UTL)** (Nevens et al., 2013)	**Urban Living Labs (ULL) as collaborative ecosystem** (Baccarne et al., 2014)

Characteristics	Structural Elements:
	- Setting the stage
	- Problem structuring and envisioning
	- Exploring pathways and building an agenda
	- Experimenting and implementing
	- Monitoring and evaluation
		Analytical Dimensions:
		- Affordance flows:
		  ○ Actor involvement
		  ○ Network collaboration
		- Value generation:
		  ○ Economic
		  ○ Public
		- Degree of techno-centricity versus knowledge reuse
		- Sustainability versus 'Future-proofness'

Complementary frameworks for analysis and development facilitation tool	**Characteristics**
Path of becoming sustainable (Nidumolu et al., 2009)	1. Viewing compliances as opportunities; 2. Making value chain sustainable; 3. Designing sustainable products and services; 4. Developing new business models; and 5. Creating next-practice platforms.
Matrix of Innovation Mechanisms in Living Lab networks (Leminen, 2013)	- Top-down versus bottom-up - Exhalation-dominated versus inhalation-dominated 1. Provider- driven 2. Enabler- driven 3. Utilizer- driven 4. User- driven

Circular economy product and business model strategy framework (Bocken et al., 2015)	- Circular Product Design Strategy:
	  ○ Closing versus Slowing
	- Circular Business Model Strategy:
	  ○ Closing versus Slowing

Value Proposition Design (Osterwalder et al., 2014)	- Understanding the creation of value; - Create a shared language and make use of experiences and skills of the team; - Minimise the risks of (new) product development failures.
Lean Start-Up Methodology (Blank, 2013)	- Testing business hypotheses; - Customer development: Testing the hypotheses by showing 'minimal viable products' with potential users, purchasers and partners to gather feedback; - Agile development: Iteratively and incrementally product development by eliminating wasted time and resources.

3. Framework and Methodology

In this chapter the focus will be on the development of a framework and on the research method. The research context will be described in Section 3.1. As stated earlier, there is no literature research done in which Living Lab concepts are applied in the CE. Nonetheless, both concepts can complement each other in order to accomplish the transition towards CE. Both concept are still emerging fields where more research is needed. For this particular reason an analytical framework will be developed in Section 3.2. Section 3.3 will elaborate more on the methodology that will be used for this research. The latter section will explain why a case study research is being selected as research method, introduce the circular building (pilot) cases, the data gathering and the type of case analysis.

3.1 Research Context

Given the research context and scope, the focus will be on co-creating and integral designing within a circular building process that is business-to-business related. The research method, as visualised in Figure 17, is based on a case study analysis to develop a conceptual facilitation tool that can support the circular building process. Before the research context was developed, an intensive literature review was done in the previous chapter. The literature provided insights into the opportunities and the adding value for the building sector by incorporating Living Lab and CE principles in selected theoretical frameworks for analysis. To gather data for the cases, semi-structured interviews with players in the field are conducted and are supplemented with data collected from desk research. With the information a design workshop was being organised to verify the collected data and to align the different perspectives of participants for further progressing the data to analyse the selected circular building (pilot) cases. These cases will be analysed by a within case analysis and a cross-case analysis, which will be explained later in this chapter. The output of the cases will be used as input for the development of a conceptual facilitation tool for the circular building process. It will be a conceptual tool due to the time constraints and need to be tested and validated afterwards.

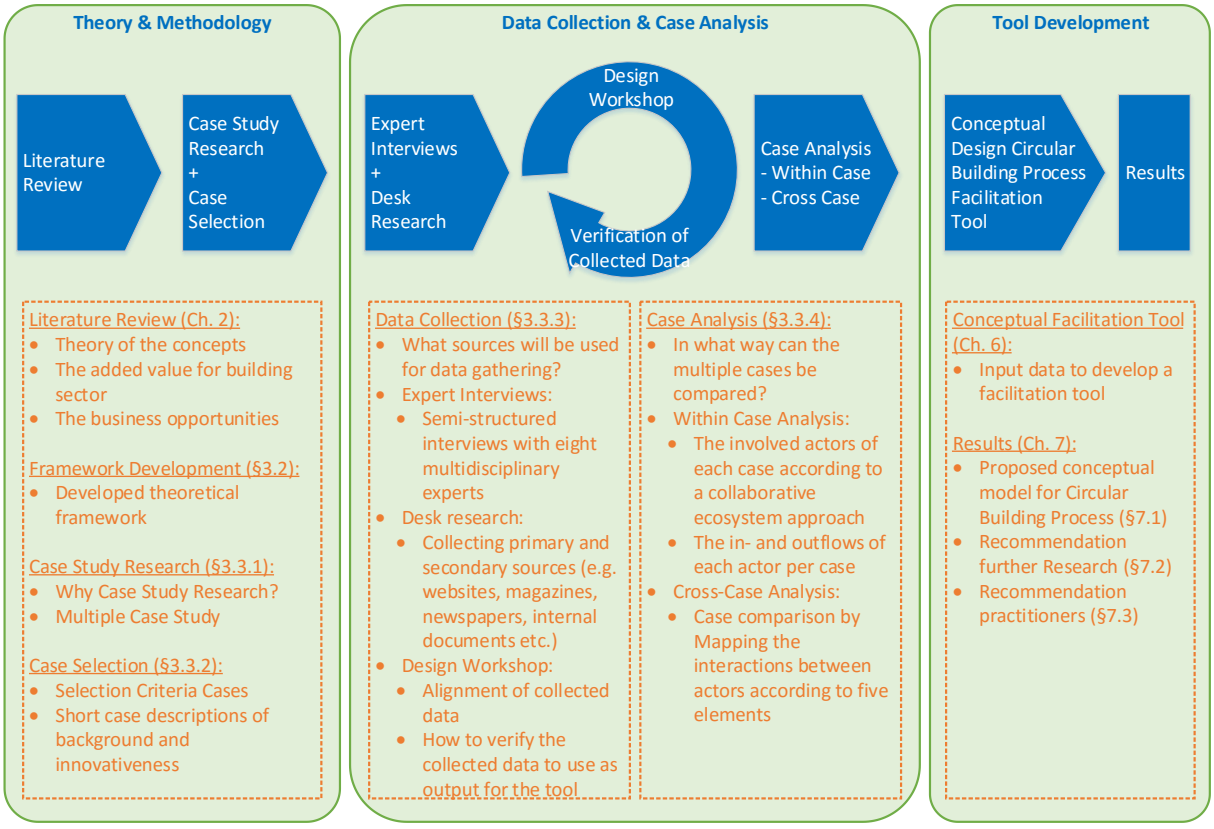


Figure 17: Overview research method and short descriptions.

3.2 Framework Development

Based on the literature a theoretical framework will be developed, which will form the basis of the analysis for this research. Therefore, a conceptual model of circular building process will be developed that is inspired by combining the concepts of ULL and UTL. This is supported by complementary frameworks (§3.2.1). This 'new' framework will analyse business-to-business circular building (pilot) cases to gain valuable results to develop a conceptual facilitation tool for the (circular) building sector.

As stated earlier, CE is still lacking in facilitating multiple stakeholders and is focused on making material flows within a process more efficiently. To make CE successful, public involvement should be stimulated. Living Labs can be complementary, because they emphasise the social aspects in which the users are the key players for innovation.

Both concepts take the user/client-centric approach as starting point to initiate the development of innovations in a collaborative manner with multiple stakeholders. How this process will be assessed to unfold a circular building process will be explained in §3.2.2. This should result in a better understanding of the needs of the user/client that can be fulfilled by tailor made innovations and development of new businesses for the stakeholders.

3.2.1 The Analytical Framework

As described in chapter 2, the study of Baccarne et al. (2014) created a conceptual and analytical framework inspired by the principles of (urban) Living Labs to analyse the architecture, the nature, and outcomes of Smart Cities. This fourfold 'architecture' conceptual model of Smart Cities is based on the idea of urban ecosystems where multiple actors interact and collaborate within a system.

By approaching the collaboration and interactions between multiple actors as an urban ecosystem it can be applied on different levels. It is about defining the system boundaries in order to increase or to reduce the complexity for the designer (van Bueren, 2012). From that respect, the 'architecture' conceptual model of Smart Cities can be adapted and adjusted in a conceptual model of the Circular Building Process that is seen as an ecosystem, see Figure 18.

By adjusting the composition of the conceptual model to the Circular Building Process, applicable for business-to-business, the fourfold network slightly differs as well. However, the four types of actor roles will remain the same (Leminen et al., 2012); 1) Users, 2) Utilisers, 3) Enablers and 4) Providers. Instead of taking the citizen as main actor in the network, it is more convenient to take the users (office building related) as main actor, because they will have more influence on the process and what a building may look like according to their needs. Mapping the key actors within a Circular Building Process is more specified then the conceptual model of Smart Cities, because constructing a building involves specific types of experts (e.g. architects, designers, constructors, installers, etc.) in the building process.

The private network is considered to be the building market, hence, the actors that produce and deliver the products and services that are needed for the construction. Research network are the actors that develop (new) theories and generate (new) knowledge, solutions and data independently of the project, but together with the industry in order to create validity and awareness. The public network are governmental actors that are responsible for the policies, laws and regulations that are relevant to the building sector and facilitate the industry to realise circular projects successfully. The users' network are all the actors who are paying, are generally affected or locals/neighbours that may benefit from a circular building project.

By mapping the key actors beforehand as a client will help them to prepare and design collaboratively, the content and organisation of a circular building project. The outcomes can be elaborated in the

process design and make it possible to reflect on them before and after the realisation of an actual circular project (Nevens et al., 2013). The interest is on comparing circular building processes in order to understand in which a conceptual facilitation tool can facilitate the process by logical steps.

Comparing the circular building processes from design to execution, the four analytical dimensions introduced by Baccarne et al. (2014) to analyse Smart Cities as a single ecosystem, does not cover the entire process. Therefore, incorporating UTL of Nevens et al. (2013) will help to understand in what way the building processes and the interaction between the network actors (private, policy, research and users) can be governed as open innovation platforms and how uncertainties can be managed that comes with sustainability.

The most interesting part of UTL is the focus on how to govern the whole process that can be tailor made within an urban context. It emphasises on co-creation and learning space in a synergetic way to bring innovative actors, researchers, frontrunners, and users together to structuring the available knowledge into action (Nevens et al., 2013). The five phases of UTL, as described in chapter 2, include a number of steps that strengthen each other with the associated activities.

Its focus is to serve the purpose of exploring and experimenting new innovative ways of governing cities by stimulating co-creation and learning possibilities. From that matter, an UTL is a way of structuring the process of decision making, integral designing and involvement of actors. However, the emphasis on executing the experimentations into business cases is not clearly described. Therefore, the Lean Start-Up concept is useful methodology to incorporate, as described by Blank (2013), to get a better understanding how the execution phase occurs and provide valuable results for businesses.

From the business' perspective the additional framework of Nidumolu et al. (2009) can be of added value to create a more comprehensive analytical framework. The key driver for innovation is to strive for the highest goal, which is in this case circularity. This means that the organisational and technological innovations are affecting the way of doing business. It will generate additional revenues, reduction of the costs, because the inputs company use in their production process or supply/value chain can be reduced, thus, more environmental friendly, and better products and services can be developed. As a result, innovations focused on circularity will in the end yield both bottom-line and top-line returns (Nidumolu et al., 2009).

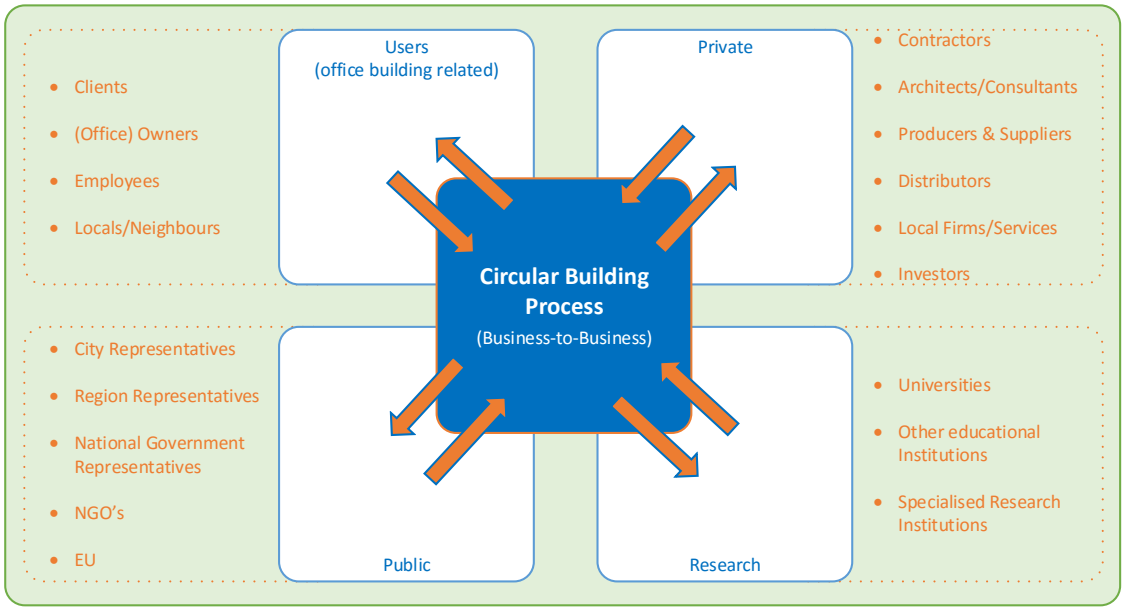


Figure 18: Conceptual model of the Circular Building process as an ecosystem including value and affordance flows between actors adapted from the 'architecture' conceptual model of Smart Cities of Baccarne et al. (2014).

3.2.2 Circular Building Process

To combine the above mentioned frameworks into one framework it is useful to understand how the process could look like, which is applicable for the circular building process. To understand and facilitate the circular building process it is divided into three processes (see also Figure 7 in Section 2.1.3): design process, construction/execution process and evaluation process. This again can be linked to the main activities of Living Labs which are co-creation, exploration, experimentation and evaluation (Westerlund and Leminen, 2011). What is missing, is that each circular building project starts, because of a certain need of an actor (public party, private party, research institute, or user). This particular actor is the initiator of the project and will start the tendering procedure by setting the conditions for the design and built process and the businesses that will be developed (Schaffers et al., 2007). Forming a future vision will also give the space and flexibility for interpretation and the ability to shape things in the present (Nevens et al., 2013; Nidumolu et al., 2009).

Inspired by the concepts of Nevens et al. (2013), Baccarne et al. (2014) and (Blank, 2013), and aspects of Nidumolu et al.'s paper (2009). The framework, as presented in Figure 18, introduces five phases with its analytical elements to analyse the design of the process, the involvement of actors and the interaction between actors during the circular building process that is considered to be an ecosystem:

- **Envisioning phase**
  - Circularity and Future vision
  - Setting the stage and Circular shared value
- **Co-creation and Exploration phase**
  - Degree of actor involvement and Collaboration approach
- **Experimentation phase**
  - Discovery and Business development
- **Execution Phase**
  - Translation of solutions and Building as Resource Depot
- **Monitoring and Evaluation**
  - Learning and Sharing experience

Envisioning Phase

The envisioning phase is the starting point of the circular building process. In this phase the client can prepare and explore their real needs, hereby, a third independent party can help facilitating them to ask themselves the right questions. During this phase, a strategy and the content will be created with multiple actors. These actors are the users and experts in their field of expertise or study (e.g. policy and technology experts). In other words, a system analysis is needed to get an overview what the perspectives, needs and opportunities are that can be integrated in a plan of approach (Nevens et al., 2013; Nidumolu et al., 2009). Based on this plan of approach a future vision can be developed and helps to establish a process design. The challenge is how uncertainties and risks are managed during the whole process. This phase will provide a circular building process design that includes the needs and future visions in the form of a tender assignment.

To analyse this phase, it is necessary to understand what the main purposes are for '**circularity'** and '**future vision'** of the particular circular building project. Circularity refers to the CE concept that set the boundaries, goals and conditions to develop a vision that fits the local or contextual setting. Defining the circular building process for a circular building by analysing the system where it is in.

Future vision links to the defined definition of the circular building process, where the vision and ambitions are driven by intrinsic motivation (Nevens et al., 2013). This shapes the future business of the client and enhances circular innovation by the steps that need to be taken for achieving a future vision.

The steps to achieve the future vision and prepare for collaboration and/or co-creation **'setting the stage'** and creation of **'circular shared value'** are necessary. Setting the stage and circular shared value are the pre-phase activities to prepare and organise the assignment for the building market (Nevens et al., 2013). This means multiple actors can participate to make explicit what the shared perception and structuring of the challenges are by expressing the key priorities or activities as guiding principles to pursue the client's vision (Osterwalder et al., 2014; Porter and Kramer, 2011). The selection procedure of the client then decides who of the stakeholders, consortia or parties get the project.

This phase can be determined as a success and effective when the actors are open-minded to share knowledge and intrinsically committed to the overall circularity agenda and goals. They should be able to translate these agenda and goals into feasible and concrete actions, which can effectively be achieved by co-creation (Bergvall-Kåreborn, Ihlström Eriksson, et al., 2009; Mulder and Stappers, 2009; Nevens et al., 2013).

Co-Creation & Exploration Phase

This phase is the next step to translate the visions and circular shared values into concrete actions. This can be considered as the first step towards operationalisation. As mentioned earlier, the key is to co-create with the committed stakeholders and involving them as early as possible in the (circular) design phase (Bocken et al., 2015; Leminen et al., 2012). By co-creating as a client with all the stakeholders together is also a way to explore what the possibilities are for private and public benefits (Lüdeke-Freund, 2010), and to build trust and chemistry in order to fulfil your vision and ambitions successfully (Nevens et al., 2013). This operationalisation step is focused on exploring the co-creative and collaborative aspects of the circular building process.

For this phase the analytical elements to understand the structure and organisation of the interactions between actors are the **'degree of actor involvement'** and the **'collaborative approach'**. The degree of actor involvement analysis to what extent the user is involved as (equal) partner and the active involvement of stakeholders within the building process (Baccarne et al., 2014). It is about understanding the participatory process and its relationship between the stakeholders and users (Bergvall-Kåreborn et al., 2010). It is based on designing products and services that are designed for, with or by the users. This is essential as the way in which a participatory design process can be governed by the actors can directly affect the design of the product or service. However, this is of concern until the final product specifications are being made, because from that point, normally, only small refinements or changes can be done (Bocken et al., 2015). To make sure that circular design gets prioritised in this phase, Bocken et al. (2015) provides a range of *circular product design strategies* as guidance and categorised them in two groups; Slowing Resource Loops and Closing Resource Loops. This should be aligned and linked back with the defined circular vision and ambitions in the previous phase. This will also influence the search for a business model that fits the product or service development (Blank, 2013; Osterwalder et al., 2014).

The collaborative approach focuses on the engagement of the stakeholders to create or fulfil certain needs. The innovation-mechanism matrix of Leminen (2013) identify and analyse recognisable Living Lab networks, hence, the circular building arena of actors. The matrix distinguishes two extreme forms of participation (Inhalation dominated versus exhalation dominated) and coordination (Top-Down versus Bottom-Up). In which participation is focused on the stakeholders' role and motivation to participate in an innovation process. Their commitment to innovate can be initiated by a specific need of an actor that need to be fulfilled, hence, inhalation or inside-outside approach. On the other hand, the innovation process can be initiated by other stakeholders by mutual interest elaborated in a collective action plan to commercialise ideas and technologies to the market, hence, exhalation or outside-inside approach. Coordination is focused on the way a process can be managed. Top-down means that an innovation process is centralised by an authority and specifies targets that need to be

met. Bottom-up is where an initiative for innovation starts with local ideas or needs from the grassroots level, which is usually informal in nature (Leminen, 2013).

By using these two extreme forms to analyse the circular building process will result in one of the four dominating types of Living Lab networks. These types are; provider-driven, enabler-driven, utiliser-driven or user-driven. These types are distinguished according to the role of the initiator that will lead the innovation process, the hierarchal level between the actors, and the role and motivation of the stakeholders.

An additional and complementary approach for the two extreme forms of coordination is the middle-out approach as defined by Janda and Parag (2013), which is more flexible to adjust and to steer the process whatever the circumstances. By adding the middle-out approach next to the innovation-mechanism matrix, the co-creation and exploration phase can be analysed more specific.

Experimentation Phase
The experimentation phase continues the operational step of the circular building design process, after the possibilities through co-creation are explored. This step is to integrate the co-created possibilities into one system. During this phase it is about finding the optimal system that will realise the future vision and set ambitions. It is about the start to discover (new) innovation systems and ways to make businesses out of it.

'Discovery' and **'Business development'** are the elements that focus on the operational side of the circular building process, which take into account value chain elements such as supply chain, operations/value propositions, workplaces/customer interface, and returns (Boons and Lüdeke-Freund, 2013; Nidumolu et al., 2009).

Discovery implies the 'journey' that actors experience when they are exploring and experimenting the possibilities in the design and build phase towards a circular building. This is the iterative process between actors to link the future vision and ambitions into concrete and feasible action agenda (Nevens et al., 2013). The iterative process also involves time and money, in which multiple actors have to deal with 'on the field' engagements, uncertainties, risks and failures that determines the degree of freedom for exploration and experimentation (Nevens et al., 2013). Analysing the process gives a better understanding what the limits are and how these limitations can be minimised by, for example, new kind of collaborations and business development strategies that fits the local setting (see also (Guzman et al., 2008)).

Business development analyses the way of doing business, because generating money is still a decisive factor if a product or service is successful or not, which is inherent to the stakeholders and users' value proposition and the way it is delivered. A successive way of doing business is to think about business development that captures (new) revenues and delivers (new) services (Bocken et al., 2013; Rana et al., 2014). New business can be developed by finding alternative pathways of doing business, questioning the current businesses and simultaneously understand the different needs of the stakeholders and users/clients (Osterwalder et al., 2014). Therefore, Bocken et al. (2015) made a distinction of two types of circular business model strategies; 'Slowing' loops and 'Closing' loops, which can be combined as well into 'Hybrid' forms. These strategies serve as guidance to develop business models for doing business in CE.

Execution Phase
This phase is the process to execute the experimentations as proven concepts, which can be seen as the **'Translation of Solutions'** into its final form; a completed circular building that also can function as a **'Resource Depot**'. This phase is also an iterative process that goes back and forth with the previous experimentation phase, because even if the circular building system is refined enough to execute and

approved by the user/client it is still possible that small adjustment and refinements are needed in practice.

This execution phase is inspired by the Lean Start-Up, as discussed in Section 2.3, which is a methodology that uses experimentation as tool to search what is really needed in practice, learn from it through feedback and execute by making a business out of it (Blank, 2013). This approach can be used for the analysis to understand the decisions that are being made to make the translation of circular solutions into practice that fit the building context. In other words, in what way do the circular solutions match with the defined circular vision and ambitions of the client.

In CE it is about preserving materials and use resources as efficient as possible by managing it accordingly. For the latter, the responsibilities and ownership will change in which the producer or supplier will become the responsible and rightful owner of the materials used in buildings during its entire life cycle, hence, EPR (Schouten, 2014). By this means a building becomes a resource depot where valuable materials or products can be preserved and will not generate much waste or scrap with no value (Allwood, 2014). For the analysis it is interesting to know if the buildings are seen as a resource depot, that it is embedded in the design and how it is interpreted for the execution of it.

Monitoring and Evaluation Phase
The monitoring and evaluation phase is essential to take the lessons learned from the processes and use the gained knowledge to do better (Baccarne et al., 2014) in the next circular building project. The learning and experiencing aspect cannot be seen as a particular phase but a continuous trajectory to learn something new each day (Nevens et al., 2013).

The circular building process is an iterative approach that stimulates an integral and co-creation development process. When multiple actors are co-creating, it is important that these actors also **'learn'** and **'share experiences'**, because then new innovative solutions can be developed. Learning and sharing experiences are strengthening each other, in which learning is related to educational knowledge and sharing experience is related to fundamental knowledge, that can change existing paradigms, hence, next-practices (Baccarne et al., 2014; Nevens et al., 2013).

It is about consistently reflecting and reflexing your steps and actions during the circular building process, because each process is unique given the circumstances and settings. Nonetheless, from each process and their solutions or lessons learned, (new) knowledge is generated and can be learned from to reproduce or adapt in other projects (Almirall and Wareham, 2008). These iterations between clients and contractors to learn and share knowledge can be categorised as 'trial-and-error' learning.

'Trial-and-error' approach is based on the process of finding the desired match. This means doing assessments on multiple alternatives with the given criteria to achieve the desired design (Sosna et al., 2010). It is continuously monitoring the development process by refining, adjusting and improving the design if necessary or favourable (Levitt and March, 1988).

Based on the elaborated introduction of the analytical dimensions, the analytical framework for the case analysis is summarised in an overview (Table 5). The framework contains a short description and its characteristics of each analytical element. Figure 19 present the visualisation of the analytical framework and its relationship between the phases.

Table 5: Analytical framework with its description that is based on Nevens et al. (2013) and Baccarne et al. (2014), and the aspects of Nidumolu et al. (2009) and Blank (2013).

Analytical Element	Description
Circular Building Process as Collaborative Ecosystem	
Full Ecosystem approach	A fourfold network of the circular building process (Policy, Private partners, Research and Users) seen as an ecosystem in which value and affordance flows are linking the actors.
Envisioning Phase	
Circularity	Defining what circularity for the particular case will be.
Future Vision	The intrinsic motivator and key driver to shape the future business of the client that enhance circular innovation.
Setting the Stage	Each circular building project is unique and need to be tailor made, thus, design and prepare both the organisation and content of the assignment.
Circular Shared Value	Aligning the process design with multiple actors that are intrinsic committed and are open to share their expertise in order to fulfil the defined visions and set ambitions.
Co-creation & Exploration Phase	
Degree of Actor Involvement	Understand to what degree the actors are (actively) involved within the participation process.
Collaboration Approach	Understanding the coordination and participation approaches in the circular building process as a (Urban) Living Lab network to stimulate innovations.
Experimentation Phase	
Discovery	The 'journey' of multiple actors through exploring and experimenting the possibilities towards a circular building.
Business Development	Finding (new) ways of doing circular businesses by capturing revenues and delivering products or services. It is about questioning the current businesses and understand the different needs of the stakeholders and users/clients.
Execution Phase	
Translation of Solutions	Understanding the decisions that are being made by the client and design team/consortium to translate the proposed circular solutions into practice that fit the building context. In other words, in what way do 'circular' solutions answer the defined circular vision and ambitions.
Building as Resource Depot	Preserving valuable materials or products used in a circular building that can be used over again during its entire lifecycle.
Monitoring & Evaluation	
Learning	Learning is a continuous trajectory that is related to educational knowledge. It is about reflecting and reflexing the steps and actions during the circular building process.
Sharing Experience	Exchanging experiences that are formed by the fundamental knowledge gained through working experiences.

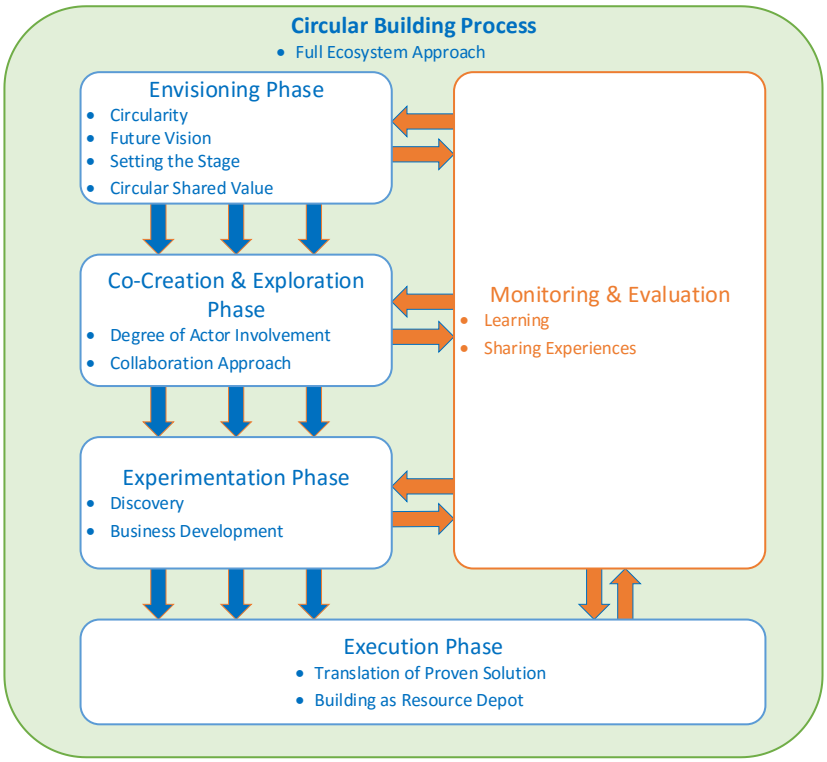


Figure 19: Visualisation Analytical Framework Circular Building Process as a Collaborative Ecosystem based on Nevens et al. (2013) and Baccarne et al. (2014), and the aspects of Nidumolu et al. (2009) and Blank (2013).

3.3 Methodology

This section will focus on why a case study research is being selected as research method (§3.3.1). The next paragraphs will introduce the circular building (pilot) cases (§3.3.2), the methods used for data collection (§3.3.3) and the explanation of the type of case analysis used (§3.3.4).

3.3.1 Case Study Research

As stated earlier, in the literature there is not much information available in which ULL are being used as an additional concept that can support CE in the building sector. To connect both concepts appropriately, a comparative multiple case study approach is selected as research method to understand the complex dynamics of CE within a real-life context (Yin, 2013). By understanding these empirical complexes in which the boundaries are still not clearly defined, an exploratory approach is considered to be useful for this type of research (Eisenhardt and Graebner, 2007; Yin, 2013). The exploratory approach can help to get more insight how a process can be understood in a more defined way by finding links and patterns within the cases (Eisenhardt, 1989). Therefore, Yin (2013) also argues that the choice of a case study research is preferable if the research question is posing a 'How' and/or 'Why' question(s).

The exploratory approach in this research is preferable, because in the building sector the process of designing and building contains multiple activities that need to be linked in order to structure a process. Each building process can be different from another and is dependent on the setting and circumstances. For this particular reason it seems reasonable to compare multiple processes to understand why certain decisions are being made by actors for a particular case.

The way of reasoning certain decisions during the building process can be insightful. To gain knowledge and experiences of the decision process a qualitative research fits better. It fits better because each designed building is based on subjective matters supported by technical facts and interpretations of

the actor's needs. The actor can be a client or an architect that might have a particular design or idea in mind for a particular setting. Each setting, can again be perceived differently because of the different tastes and/or emotional/intrinsic value of actors. Therefore, quantitative evidence in this case is not enough to understand these values, but can be supportive to identify qualitative evidence and vice versa. Thus, a case study does not imply that only one particular type of evidence can be used, it can be combined as well (Eisenhardt, 1989; Yin, 1981, 2013). It depends on the research setting that is decisive what data is needed.

Building on the above and using the practical experiences of the involved parties of the pilot cases as reference, circular building processes can be analysed. Therefore, qualitative evidence fits better, because these pilot cases are projects that can be learned from. In this research, the scope is fixated on the way how multiple actors are involved in the circular building process, lessons learned and the practical experiences. Qualitative evidence can be gathered through observation, interviews, verbal reports and desk research or a combination of these for the selected pilot cases (Yin, 1981, 2013) to understand the processes and finding the patterns between the cases.

Finding the patterns by cross case analysis is important to understand the replication logic of each case that will be selected, which is based on either a) a *literal replication* in which similar results will be predicted or b) a *theoretical replication* in which contrasting results, but for predicted reasons will be provided (Yin, 2013). For this research a few cases will be selected that benefit the use of a literal replication (Yin, 2013) and will be elaborated more in the next section. For the selected cases, the unit of analysis will be focused on the co-creative and integral design process of circular buildings in which the stakeholders and the users/clients are actively involved.

The actively involvement of stakeholders and users from the start of the design or development process is one of the key aspects that is embraced by the Living Lab (Mulder et al., 2008; Niitamo et al., 2006). The necessity of this aspect becomes even clearer with the success stories of designing Circular Buildings and the acknowledgement it gets for their innovative methods and approaches.

3.3.2 Circular Building (pilot) Cases

As mentioned, the research will focus on literal replication in which similar results will be analysed. The selection of cases is essential to provide a solid base in which particular patterns can be found (Yin, 2013). This should result into a developed theoretical framework that can be validated again by new cases in which similar cross-experiments design can be done with the same structure, measures and testable theoretical propositions (Eisenhardt and Graebner, 2007).

In order to develop a theoretical framework in which ULL is applied in CE three (pilot) cases are provided to make a comparative analysis: Town Hall of Brummen, Circular Office of Alliander and Cradle-to-cradle City Hall Venlo. These (pilot) cases are provided because they are considered as the success stories in the practical field of circular buildings in the Netherlands. These cases already have completed their design process and are being build, and are delivered or soon to be delivered.

What these cases have in common is their multidisciplinary approach and setting example of using an innovative way to facilitate the design and build process from a circular perspective. This is about what the intrinsic motivations of the clients were and what they have done differently compared to the more traditional approach. It is about formulating the (tender) assignment for the market. For the Town Hall Brummen their driver was its fixed budget, but asking for high circular and sustainable standards based on functional product performance. For the Circular Office Alliander they formulated five visions based on CE principles as criteria for their office. In the case of the Cradle-to-cradle City Hall of Venlo, the regional Cradle-to-Cradle vision was taken as leading criteria.

Town Hall Brummen

Tender Assignment	Semi-permanent housing with a lifespan of minimum 20 years.
Core Design of Circular Building	Design for Disassembly/Deconstruction
Building Type Activity	Renovation, New Build
Location	Brummen, Province of Gelderland
Surface	3,300 m^2
Delivery	March 2013

Background

The municipality of Brummen wanted to build a healthy, enjoyable and sustainable working environment for their officials that was situated in a monumental villa and connected with a semi-permanent building for the coming 20 years. Unfortunately, their ambitions did not fit with the current building so they decided to renovate the villa due to its cultural value and extended it with a semi-permanent building. However, in their opinion this semi-permanent building was not just an extension, thus, they set their ambitions really high to ask for the state-of-the-art sustainable solution that still fitted within their very limited budget. Despite the fact that the ambition of the Municipality of Brummen was set high and the budget was limited, RAU Architects took this change as an opportunity to implement their own vision of Circular Economy. In the end, this resulted in an expansion of the monumental Villa that seamlessly harmonised both the Villa and the newly build expansion.

In the very end the design & build team of this project has built a setting example of circular buildings. It showed that due to the financial crisis and the limited budget it was still possible to realise their ambitions.

Sources:	http://www.bamutiliteitsbouw.nl/ http://www.dearchitect.nl/

Circular Office Alliander

Tender Assignment	Five ambitions need to be fulfilled
Core Design of Circular Building	Reuse of Materials
Building Type Activity	New Build (Relocation), Renovation
Located	Duiven, Province of Gelderland
Surface	25,500 m^2
Delivery	November 2015

Background

A 30-year-old five office building complex with a surface of approximately 26,000 m^2 of Alliander in Duiven was ready for redevelopment. Alliander was considering the following options for their five existing offices: total demolition or (sustainable) renovation. They have chosen for the last option and decided to redevelop their old building complex according to the principles of circular economy, hence, make use of, as much as possible, reused and recycled materials. One of the questions that Alliander asked themselves was 'why do we not use our old toilets that are still functioning instead of buying new ones?' (Bouw Totaal, 2014). This was also one of the assignments provided by Alliander that was part of their five ambitions that they have put on the market for tendering.

What made this project really unique in the building sector was that Alliander did not asked for a product, but for a process without a clear endpoint and asked the market to provide them with solutions (Doodeman, 2014). That is also the reason that this whole redevelopment of buildings towards circularity is currently chosen as a setting example for building circular in the 21th century.

Sources:	http://www.boele.nl/ http://www.cobouw.nl/ (Bouw Totaal, 2014)

Cradle-to-Cradle City Hall Venlo

Tender Assignment	Client asked architects to present their vision based on client's Cradle-to-Cradle ambitions.
Core Design of Circular Building	Cradle-to-Cradle Inspired
Building Type Activity	New Build
Located	Venlo, Province of Limburg
Surface	13,500 m^2
Delivery	(expected) begin of 2016

Background

The municipality of Venlo decided in 2007 to make their ambitions as becoming the Cradle-to-Cradle (C2C) hotspot concrete by building a C2C City Hall. Their idea is to create a building that facilitate a pleasant and healthy workplace for the employees of the municipality of Venlo. The building must be designed for its users and residents, culture and place, and it must be flexible for continuous improvement and future innovations.

In the end this project was a showcase of how C2C-priniciples and ambitions can be of economic added value, stimulate sustainable innovations and simultaneously can improve the quality of work and life in the direct surroundings. It also showed that a circular process can be encouraged by the internal organization in which circular models were integrated in (governmental) projects and policy.

Sources:	http://www.kraaijvanger.nl/ http://www.c2c-centre.com/

3.3.3 Data Collection

The use of multiple case study will develop the initial design of a tool that will provide the idea how urban Living Lab can be applied in the circular economy. The three cases were selected due to their innovative way of tendering and selection process in order to design a circular building. These cases are also examples on how users and stakeholders can be involved to improve the innovation process in a real life setting, i.e. built environment, that stimulate companies and organisations to think more in terms of what is needed by them instead of what is needed for them.

As mentioned earlier, the literature is lacking data on how urban Living Labs can be applied in the circular economy. In practice, combining both concepts are also limited with data and is not well developed yet. To bridge the information gap between urban Living Labs and circular economy, desk research and interviews will provide data. The data itself will be mainly qualitative, because the unit of analysis is focusing on the process of designing circular buildings that emphasises co-creative and cooperative approaches.

To get a better understanding, eight semi-structured interviews were conducted. Five of the semi-structured interviews focused on the provided cases separately (Table 6) and three were additional to gain extra input for the overall cross-case analysis and circular building process in general (Table 7). The list of formulated interview questions (in Dutch) for the semi-structured interviews can be found in Appendix A (the English version of the questions can be found in Appendix B). This was in Dutch because all the interviewees of the companies were Dutch speaking. The transcription of the interviews can be found in Appendix D and Table 9 for referring to the transcription. The duration of the interviews was between the 45 minutes-90 minutes and explored the following topics:

- The definition of Circular Economy and Living Lab concepts and its relevance for the Dutch building sector;
- The main results, outcomes, and lessons learned from their circular or Living Lab projects and cases and how they involve their stakeholders and users;
- The reason why these projects/cases are considered circular or Living Lab concepts and what makes them different from other projects/cases;
- The drivers for circularity and/or Living Labs, and the challenges that companies or organisations have faced during their circular or Living Lab project and/or case;
- The competencies needed during the design process and the opportunities for the building sector to become circular.

Based on literature, case studies, interviews and workshop, a facilitation tool will be developed. This tool applies aspects of Urban Living Labs in the concept of Circular Economy to facilitate the circular building process. Therefore, a multidisciplinary workshop is being organised to validate the input of the interviews and literature. Multidisciplinary because the ones that were invited to participate had different disciplines as background. This included the interviewees and some additional guests that made it a diverse group of participants (see list of participants in Table 8). The results of this workshop serves as input to support the cross-case analysis and to develop the conceptual facilitation tool.

The main objective of the workshop is the translation of the gained input on how Living Lab aspects and elements can be applied in the circular economy into concrete steps. The focus of this workshop is on the envisioning phase of the circular building process, because during this phase the fundamental elements of planning and designing a circular building will be defined. Within this phase the interaction and involvement between multiple actors is also very high.

To explore the envisioning phase with the participants the structure of the workshop is inspired by the five stages of 'The Path of becoming sustainable' that Nidumolu et al. (2009) that is described in Section 2, Table 1. The process of the workshop starts by defining a circular vision for the building sector with

the group and followed up by exploring the first three stages of Nidumolu et al. (2009). This will help to go more in details to get a better understanding what the real needs and values are within a Circular Proposition Design. The next step is to think how this can be embedded in a (new) business model.

Table 6: List of interviews of each case for the within case analysis.

Project/Case	Topic	Type of Company	Role	Interviewees
Town Hall Brummen	Design & Build based on performances	Consultancy	Contractor	Project Leader
Circular Office Alliander	Design & Build based on vision and ambitions	Utility	Client	Project Leader
Circular Office Alliander	Facilitation of defining the vision and ambitions for tendering	Consultancy	Facilitator	Project Coordinator
Circular Office Alliander and Town Hall Brummen	Circular Buildings	Architect	Contractor	Project Architect
City Hall Venlo	Design & Build based on Cradle-to-Cradle vision and ambitions	Architect	Contractor	Project Coordinator

Table 7: List of interviews as additional input for the overall cross-case analysis and circular building process in general.

Project/Case	Topic	Type of Company	Role	Interviewees
Overtoomseveld Amsterdam	Sustainable Demolition	Demolition	Contractor	Commercial Director
SPARK Campus	Living Lab Platform for the Built Environment	Platform	Support	Managing Director
Green Deals 'Circulaire Gebouwen'	Circular Buildings	Public	Support	Category Manager on Waste and Resources

Table 8: List of Workshop Participants to validate and align the gained information from literature and the interviews that provide additional input and support for the overall cross-case analysis.

Company	Type of Company	Type of participant	Number of workshop participants (not author)	Purpose
Alliander	Utility	Industry	2	Circular Building Case Example
RVO-Nederland	Public	Governance	1	Green Deal Circular Buildings
Oranje-BV	Demolition	Industry	1	Sustainable Demolition
Koninklijke Bibliotheek	Library	Governance	1	New Pilot Case Green Deal Circular Buildings
ICE-Amsterdam	Consultancy	Industry	1	CE Expertise

Table 9: List of interviewees with corresponding reference for the full interview transcription see attachment of Appendix D.

Name	Company	Project/Case	Reference in text
Maartje van den Berg	Blossom Consultancy	Town Hall Brummen	(Maartje van den Berg, 2015)
Cassandra Vugts	SPARK Campus	SPARK Campus Living Lab	(Cassandra Vugts, 2015)
Eugenie Knaap	Alliander	Circular Office Alliander	(Eugenie Knaap, 2015)
Edward Timmermans	Kraaijvanger Architects	Cradle-to-Cradle City Hall Venlo	(Edward Timmermans, 2015)
Marijn Emanuel	RAU Architects	Circular Office Alliander & Town Hall Brummen	(Marijn Emanuel, 2015)
Joan Prummel	RVO-Nederland	Green Deals Circulaire Gebouwen	(Joan Prummel, 2015)
Gert Jan de Gier	Oranje BV	Overtoomseveld Amsterdam	(Gert Jan de Gier, 2015)
Anouk van der Have	Copper8	Circular Office Alliander	(Anouk van der Have, 2015)

3.3.4 Case Analysis

The proposed conceptual model of circular building process as collaborative ecosystem and the four analytical dimensions are essential to analyse the interactions between stakeholders and users during the tendering, design & built, and monitoring & evaluation processes. This will form the basis to map the main stakeholders and users in the circular building process.

The analytical framework will be used to perform a within case and cross-case analysis on the three selected cases. This conceptual model will give insight which actors are involved. By mapping the actors, it becomes clear which key stakeholders need to be involved to successfully accomplish a circular building. This also assess if an ecosystem approach is a way to structure the setting to facilitate the development process. The arrows in the conceptual model represent the value and the affordance flows between the actors and the development process, each system provides input and output for another system.

Operational wise the circular building process is mapping the underlying interactions between the actors and the associated activities. The circular building process as an ecosystem introduces and suggests four phases, each with the associated analytical dimensions, as visualised in Figure 19.

Each case will be first analysed according to the within case analysis in order to understand in more depth what the circumstances were and why they made certain decisions to do it differently. After analysing each case separately, the three cases will be compared in order to find certain patterns that explains the phenomena of a circular building process. The results and outcomes of the comparison will be used to develop a conceptual facilitation tool that incorporate the ULL and UTL inspired elements into a Circular Building (Living Lab) Process.

To summarise, the development of the conceptual facilitation tool will be based on ULL and UTL inspired elements that can be applied in CE, which is based on multiple case study research as described by Eisenhardt (1989) and Yin (2013). The analysis of the cases will be focused on the active involvement of stakeholders and users for business innovation during the circular building process within a local context. By semi-structured interviews and desk research, and comparing the cases by mapping the actors and the stages of the development process, insightful outcome will be generated to develop the conceptual facilitation tool.

4. Findings for Circular Buildings

This chapter will elaborate the findings of the interviews with the experts in the field (Appendix C, for referring to the interview transcription in the text see Table 9) and the desk research to analyse the three cases: Town Hall Brummen (Section 4.1), Circular Office Alliander (Section 4.2), and Cradle-to-Cradle City Hall Venlo (Section 4.3). These results and sources can be found in Appendices E and F. First the within case analysis will be carried out based on the collaborative ecosystem by analysing the role and involvement of the actors in each case. Followed up by the cross-case analysis (Section 4.4) where the three cases will be compared to find the patterns, similarities and differences.

4.1 Functional Performance Based Town Hall Brummen

In Table 10 the overview of the affordance flows and value generation between the involved actors of the functional performance based model Town Hall of the Municipality of Brummen is presented. Within this overview the flows of each actor are analysed, in what they provide or get from the collaborative ecosystem.

Table 10: Mapping the actors and overview of the affordance flows and value generation of (pilot) case Brummen according to the conceptual Circular Building Process as a collaborative ecosystem

Town Hall Brummen		
Client	Municipality of Brummen	
Main Contractors	RAU Architects, BAM Utility	
Private	• Glass Roof: Brakel Atmos • Green Roof: Moster de Winter • Interior: Van Brakel Interieur	• Wood Construction: GLC • Façade: Oskomera • Installation: BAM Technique
Policy	• Municipality Brummen • Province of Gelderland	
User(s)	• Employees of the Municipality of Brummen • Citizens of Brummen	
Type of Tendering	European Tendering Procedure	
Type of Contract	Design & Build (D&B)	
Overall Circularity	90% of all the materials can be disassembled and be reused.	
Actors/Stakeholders	**Input** ↓	**Output** ↑
Private	Technology and Research Insights (Enabling Knowledge), Involving local suppliers as much as possible (Enabling Local Potential Economic Value) and the use of systems that can be disassembled after 20 years (Enabling Environment).	Resource/Material Depot (Enabling Environment)
Policy	Semi-permanent building with a lifespan of at least 20 years (Enabling Social & Cultural Value and Potential Economic Value), policy advice (Enabling Knowledge) and City Funding (Enabling Funding)	Transparency and open communication citizens (Enabling Knowledge and Social & Cultural Value)
Users	Voices of what the (new) Town Hall should represent and what the needs are (Enabling Social & Cultural Value, Enabling Knowledge)	Involvement and value propositions (Social & Cultural Value)
Research	-	-

The circular building process of Brummen was different compared to the traditional process in the way that functional performance outweighs the price during tendering. The tendering process itself was unique and innovative. It was unique because it was one of the first tender assignment that was focused on the principles of CE. It was innovative because of the way the tendering process was coordinated. They asked for functional performances as results; these were based on the created preconditions. As Maartje van den Berg, consultant and project coordinator, stated in her interview: *"It is not prescribing the wanted solution, but asking for the wanted results"* (translated from Dutch).

To coordinate the process, a public-private partnership or what they called a *Design & Build and Maintenance construction* has been chosen. With this collaborative approach private and public parties cooperate together along the value chain. Design, build and maintenance were included as one tendering process. As mentioned by Maartje van den Berg in her article in the magazine of "Stedebouw & Architectuur" (December, 2014) it stimulated the relevant actors to think also about the lifecycle of the building.

As the collaboration approach points out, it was a public-private partnership in which the collaboration was mainly focused on the interaction between private partners and public partners. However, by asking for functional performance conditions or results the users must be involved more intensively in order to understand their needs. The category research in this case was not included in the process.

The cooperation with suppliers' and contractors' main focus was to incorporate different systems into one integral performance based design, which could be disassembled afterwards. Due to this integral design approach the process was not about taking steps in sequences, but taking integral steps in which each expert could focus on its core business. It was not about one company as the contractor but a multidisciplinary team of experts. The municipality of Brummen as the client and user was not the one that was responsible to take the lead in the whole process, but they had their voice of what they wanted and needed. In this case the design team was formed by RAU Architects and BAM Utility and took the lead of the project.

The design team as experts were the ones that translated their needs in concrete action points. To define those points, they started an open dialogue with the users, inhabitants of Brummen and stakeholders and listened to them in order to make a matching design proposition. As a result, producers and suppliers became more responsible to deliver products/systems that, at least, matched the defined functional performances. This had as effect that performances became more important instead of the price, which had again its effect on businesses to give the best value for the right price. The involvement of the citizens of Brummen, relevant stakeholders and the open communication approach of the municipality resulted in more support and less resistance for this project. Even now the citizens are still proud of their newly renovated Town Hall and got international exposure because of its innovative designing and building process (Maartje van den Berg, 2015).

4.1.1 Circular Building Process: Collaborative Ecosystem

The main difference between the traditional way and the innovative way of the project Town Hall Brummen of a building process, is that the performances outweighed the price. It was the limited financial framework and ground of exclusion that the price was not the decisive factor. For the client it was not meant to give in on quality, instead, they put the emphasis to strive for high quality and sustainability standards with a limited budget. The whole design and build process was focused on an integral design (Maartje van den Berg, 2015). To understand the process as a *Circular Building Process as an Ecosystem*, Table 11 summarised the within case analysis of the Performance Based Model Town Hall Brummen. The elaborated analysis of the phases is described in the next paragraphs.

Table 11: Summarised Within Case Analysis Town Hall Brummen.

(Pilot) Case	Town Hall Brummen	
Full Ecosystem approach	No	
Intensity Collaboration	High at the beginning Medium during the process itself	
Envisioning Phase		
Circularity	Design for Deconstruction (Disassembly), Modularity, Reuse of Materials (Demolition)	
Future Vision	Semi-permanent and representative building for at least 20 years with high sustainability standards (technical, experience and usage) with a limited budget.	
Setting the Stage	Multiple party dialogue to develop ambitions.	
Circular Shared Value	Functional performance based as designing criteria Value creation: - Social: Old and new becomes one and based on the expectations of the citizens. - Economic: Resource depot and shift of responsibilities and ownerships. - Ecologic: Fit in the environment.	
Selection Procedure	Fixed budget and high sustainability standards: Asked for a solution for their future vision	
Co-creation & Exploration Phase		
Degree of Actor Involvement	From the start of the design process Design For Users	
Collaboration Approach	Participation approach:	Exhalation Dominated
	Coordination approach:	Bottom-Up
	Innovation-Mechanism:	Enabler-Driven
Experimentation Phase		
Discovery	Integral	
Business Development	Circular Product Design:	Slowing
	Circular Business Model:	Slowing
Execution Phase		
Translation of Solutions	Responsibilities of the experts through contract management. Approval by client; 'best' value for the right price.	
Building as Resource Depot	Partly, because designed to deconstruct but no firm agreements made for a take-back system.	
Monitoring & Evaluation Phase		
Learning	Trial-and-Error	
Next Practice	No	

4.1.2 Envisioning Phase

For the tendering process the municipality of Brummen asked for a semi-permanent and representative building, which could be disassembled after twenty years. For the construction of the building, high quality and sustainability standards were asked. Before this tendering process was being put on the market, the pre-phase was focused on defining the ambitions and future vision by asking for input from the citizens. To involve the citizens for input, they organised public sessions to ask them what they wanted and needed of a new Town Hall.

The input of these open dialogues and the need for a semi-permanent building, the core building design is formed by the idea of modularity that takes into account the lifespan of the building. With a limited budget the municipality formulated ambitions that were based on high sustainable

performance. This included that when the building will be disassembled, the materials and resources will return to the rightful suppliers. These were the definite conditions where suppliers and contractors could apply for. In the online magazine “Architectenweb” Aldo Trim (July 2013) described that the design team was formed beforehand to stimulate an integral design process. The design team was formed by RAU Architects, Royal BAM and Co.

To safeguard the conditions, the pre-phase and the tendering process was based as a Design & Build Contracting, in which design and realisation are embedded in one contract. Due to the contracting, the programme of requirements could be emphasised on high quality sustainable performances such as technology, experience and usage, and the responsibilities of the materials and resources could shift to the suppliers and contractors. For this particular reason RAU Architects and TurnToo have decided to approach this project differently by making use of resources in a different way but up keeping high quality standards. This has led to change of the function of the Semi-Permanent Town Hall into a resource depot. As Maartje van den Berg described in her article in the magazine of “Stedebouw & Architectuur” (December, 2014), for tendering a clearly defined visions for the desired results should be common, a programme of requirements that is based on performances.

For the future vision, the semi-permanent building is connected to the monumental villa, that should be disassembled completely without affecting the cultural and social value of the surroundings; the process can be seen in Figure 20. RAU and BAM have decided to design a building that blends with the environment and where old and new become one. Therefore, they incorporated the demolition of the old extension of the monumental villa in their design. Unfortunately, they used the demolition ‘waste’ mainly as resource to fill up the gabions that is used for the new building extension, but for the theme; where old and new become one, it is an effective way to make it visible.

The circular shared value that is created is to fulfil the needs of the citizens and users by asking what they want of their new town hall. For the suppliers and contractors, this was by introducing the resource/material depot that is based on the idea to retain the value of materials. The responsibilities and ownership of the products, materials and resources shifted to the suppliers and producers. In other words, making the suppliers responsible owners of the materials during its lifecycle also means that they have an incentive to think of and maintain its economic value in the long-term. This means collaboration throughout the value chain is necessary to develop an integral design or system in which the involved actors can maintain its value through circular shared value creation when it will be dissembled after twenty years.

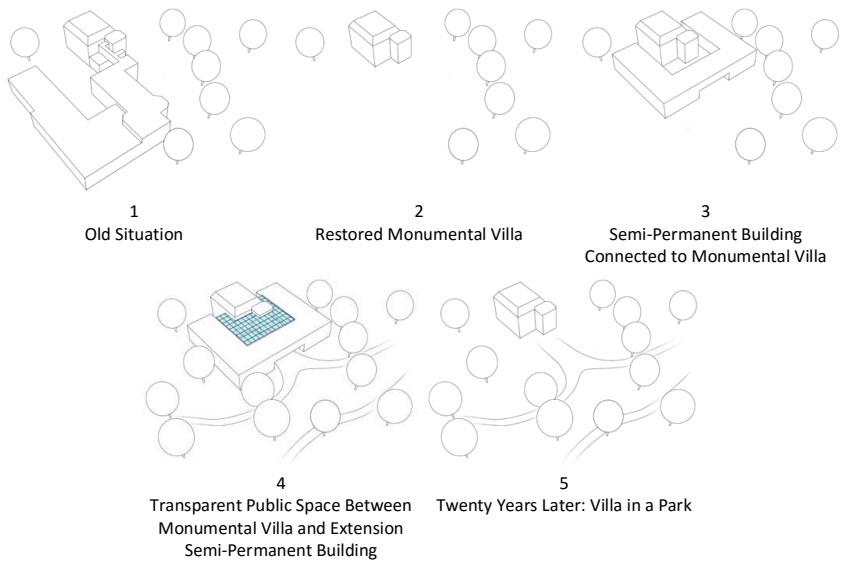


Figure 20: Visualisation Present and Future Vision Town Hall Brummen, 2013-2033 (derived from RAU Architects, 2013)

Analysing the envisioning phase of the (pilot) case Brummen their approach has resulted in a future vision supported by defined functional performance conditions to strive for high quality and sustainability standards for at least twenty years. This resulted in a design that is compact, representative, fit in the environment, where old and new become one and 90 percent can be disassembled for reuse.

4.1.3 Co-Creation & Exploration Phase

In the envisioning phase the users and citizens were asked to give their opinion about what they expect of their new town hall. This created the predefined functional performance conditions. To translate these conditions into concrete plans a preselected design team was formed. This design team was a team of experts who were asked and trusted to come with (innovative) solutions.

The involvement of the users and citizens were in this particular case active in the beginning to gain input. After the boundary conditions were set, the users and citizens were not actively involved anymore. The actor's involvement shifted towards the experts to translate the conditions in concrete actions. During the design and development process, the citizens did not have that much input, because the contractors and suppliers signed the contracts and started to develop products that matched the needs and ambitions based on functional performance. The results of these products were then approved by the client, based on 'best' value for the right price (Maartje van den Berg, December 2014). Nonetheless, the municipality was still transparent with their communications and kept their citizens and users updated about the work in progress.

The municipality and the design team have chosen to build their circular building on behalf of the users, hence, a system design by applying the participation process '*design for users*'. By involving the users at the beginning of the process through open dialogues meetings and transparent communication, the municipality of Brummen as the project coordinator is considered to be a collaboration, that is coordinated according to a '*bottom-up*' approach. This also became clear in the way that the meetings between experts were not seen as 'regular' meetings, but as meetings grounded on intrinsic motivation to help and support each other in the process (Maartje van den Berg, 2015). The reason that they were intrinsically motivated to help was because of the responsibility they had during the whole process. This stimulated the co-creation and exploration process to find possibilities to create solutions that benefits all the stakeholders. As an example, a wood constructor thought about its wood construction to match with the conditions and also what its economic gain would be when disassembled. He came to the conclusion that the wooden construction should be thicker then designed with no holes for cables. This proposition, obviously, affected the overall system design. To implement this solution of the wood constructor other actors had to cooperate in order to think about new possibilities and solutions to fulfil each other needs, hence, an '*exhalation dominated*' (Outside-Inside) participation approach.

Seen as an urban Living Lab network, this form of collaboration approach for innovation, bottom-up and exhalation dominated, is categorised as enabler-driven. This innovation-mechanism provided solutions that match the needs of the user to improve the overall circular building design.

4.1.4 Experimentation Phase

Towards a circular building design is a journey to realise your visions by experimenting new possibilities. For Brummen the whole building process was unique and innovative, because by then the crisis was still having its effect on the economy and the concept of CE was at its very beginning. Thomas Rau introduced them with the concept of CE and also provided them with an innovative business model called the TurnToo Business Model. According to this business model, certifying the products are not necessary anymore and the client does not buy products but services for the usage and will not become the responsible owner. As explained by Clairette Gitz in her article in the magazine "de Architect" of

September 2013 this means the supplier or producer will be the responsible owner for everything that is related to the product in order to provide the service that is asked for. A change in mind-set of producing products will then occur, which can be seen as a sort of journey to transform a business model to make it profitable when reusing the products over and over again. This means as a supplier or producer to redesign the products for reuse that can meet the expectations.

What happened during the building process was that the suppliers and producers were focused on how they could design their products that could be disassembled after its usage and still had economic value to reuse it for another building. This has led to development of several integrated systems produced by a particular supplier or producers that fit within the integral design and could be dissembled afterwards without conflicting other integrated systems. Therefore, the design of the products follows the principle of slowing resource loops by designing the products to extend its life and follow the slowing business model that combines performance and extension of product value (Bocken et al., 2015) over a period of at least twenty years. The experimental journey of the Brummen case focuses on the products/materials/resources of the supplier and producer itself as a resource depot that meets the ambitions of the client and fits within the integral design approach that was presented by RAU Architects.

4.1.5 Execution Phase

As noted, RAU and BAM made a design of semi-permanent building that blends in with the environment and where old and new becomes one. For the execution of these design the client and the design team signed a design & build contract where all the vision, ambitions, requirements and responsibilities were elaborated. According to Maartje van den Berg (2015), to execute ideas and solutions into practice is to be explicit that the contractors are evaluated by their performance obligations. It is not the product they must deliver, but a product that meet at least the functional performance. To make the decision, if the product meet at least the functional performance, the client developed a list of criteria. Based on this list of criteria, the client and design team give its approval or not if it is the 'best' value for the right price (Maartje van den Berg, December 2014).

Nonetheless, even if the product has its approval for execution, in practice there will always be some problems and complications that need to be taken care of. This was also the case during the execution of the building construction several times, because the users want a lot or want things differently or have too high expectations without thinking if it is doable. To explain why certain decisions are being made, communication was very important. This was one of complications that needed to be taken care of during the execution of the project; clear communication and manage the expectations of the users.

They solved these problems and complication by intensive communication and made their decisions according to the agreements and conditions in the contract. As Maartje van den Berg (2015) stated in her interview it is about contract management that can solve some problems. You need go back and forth to see if the problems or complications that occur are within the affordable margin/range to be solved properly or not. This is a way to tackle problems, however, this could be less of a problem if the users were still actively involved along the process and not only during the envisioning phase. If the users were given the opportunity to give more feedback and to go in dialogue with the experts regularly, instead of getting the latest updates, they would understand the process better. It might even have led to a reduced need of users to ask questions 'why' certain steps were being made that way and 'when' other steps could be taken.

As client, it is good to make the experts responsible and let them come with solutions that fit the needs and ambitions during the execution phase. However, as stated above, users might be questioning why it is done that way and not another way and then as client you must take the responsibility to explain 'why'. Thus, by contract management the client shifts the responsibilities of the translation of solutions

to the experts, but in the end they make the final decision for approval to execute. The contract was in this case the proof that the experts were committed to follow and fulfil the circular vision and ambitions.

The semi-permanent building that is delivered by RAU Architects and BAM was based on designing a system that could be deconstructed after twenty years. From that perspective, the building acts as a resource depot, because after its usage the building materials would be taken back by the producer or supplier. Unfortunately, the intention was to develop a resource passport for the building, but due to the complexity in what form and how it should be documented was still ambiguous, they did not continue with this idea. As a result, they also did not make firm agreements what would happen if the building materials and products would be taken back after its usage, even though, it is designed to be easily deconstructed. As Rolinde Hoorntje pointed out in the article: *"Klaar om weer af te breken"* of the NRC Next (19 September 2013) this was because the tendering was not initially structured for CE and making changes afterwards were difficult and would be conflicting with law and regulations.

4.1.6 Monitoring & Evaluation Phase

Unfortunately, the (pilot) case of Town Hall Brummen cannot be seen as a real example on how circular building proceed. The reason is, because the Municipality of Brummen decided to deviate from the agreed conditions with RAU Architects. Instead of following the suggest TurnToo business model, they decided to depreciate the building on a time span of forty years in order to allocate extra funds for other municipal projects. Nevertheless, the project gained enough exposure and new insights how circular building can be developed. Due to innovative way of approaching, the tendering process by asking for performance and high sustainability with a limited budget have opened new opportunities and possibilities. By sharing their experiences, knowledge and the *'trial-and-error'* process, the municipality gained a lot of exposure nationally and globally, and put the village on the map.

The lessons that can be learned from this particular case is that a project, which stimulates an integral approach, cannot be coordinated by a contractor of one company. It should be coordinated by contractors that acts as a multidisciplinary team of experts. This means that the user/client will not be the one who is responsible to take the lead in the whole process. The contractors are the ones that are responsible to deliver the wanted performances, because they are considered to be the experts, not the client (Maartje van den Berg, December 2014). By moving the responsibilities towards the experts, they will be challenged and stimulated to use all their knowledge and creativity to come up with innovative solutions, even if the budget is limited. Starting an open dialogue already at the beginning of the process with your users and stakeholders will help the client to get a better understanding of what they really want, need and expect. This creates support and reduce resistances from the users and stakeholders. It saves time and money, and results in a building where people are proud of. To achieve these results, it is important that the tender specification is based on functional performances, high quality and sustainability that is motivated by the ambitions of the client. By emphasising on the ambitions the price will not become the decisive factor. This again should be regularly monitored to keep an eye if the project is still fulfilling the ambitions and needs.

To conclude, the main characteristics of this case are:

- Ambitions are the leading criteria;
- Involve users and stakeholders in the pre-phase;
- Functional performance based tender specification derived from the ambitions;
- Integral approach;
- The contractor is a multidisciplinary team of experts;
- Suppliers and producers are responsible for their choices to fulfil the wanted performances;
- Open and clear communication;
- Contract management.

4.2 Circular Office Alliander

In Table 12 the overview of the affordance flows and value generation between the involved actors of the Circular Office Alliander is presented. Within this overview the flows of each actor are analysed what they provide or get from the collaborative ecosystem.

Table 12: Mapping the actors and overview of the affordance flows and value generation of (pilot) case Alliander according to the conceptual Circular Building Process as a collaborative ecosystem.

Circular Office Alliander		
Client	Alliander NV	
Main Contractors	RAU Architects, VolkerWessels Real Estate BV	
Private	• Process facilitators/consultants: Copper8 • Architectural work: Boele & van Eesteren • Interiors: Fokkema & Partners • Installation: Innax	• Landscape: Kuiper Compagnons • Construction: van Rossum Raadgevende ingenieurs • System innovation: Turntoo
Policy	• Municipality of Duiven • Province of Gelderland	
User(s)	• Employees of Alliander NV	
Type of Tendering	European Tendering Procedure	
Type of Contract	Design & Build and Maintenance	
Overall Circularity	83% of the five old offices is kept intact on the building complex. Minimum 80% of the new building is made of recycled/circular materials and it will generate energy.	
Actors/Stakeholders	**Input**	**Output**
Private	State-of-the-art Technology and Research insights (Enabling Knowledge), multidisciplinary consortium (Enabling Potential Economic Value and Enabling Knowledge)	Resource/Material Depot (Enabling Environment)
Policy	Policy advice (Enabling Knowledge)	Facilitating the region sustainability goals (Enabling Environment), best practice case (Enabling Social & Cultural, Economic and Environmental value) and BREEAM-Certification (Enabling Environment)
Users	Vision and Ambitions (Enabling Environment, Potential Economic Value, Social & Cultural Value) and local funding (Enabling Funding)	Participation (Enabling Knowledge) and co-creative and integral design (Enabling Knowledge and Potential Economic Value)
Research	-	-

The Alliander Circular Office is another case that was unique and innovative in their way of formulating the tendering and selection process. Alliander formulated with an independent third party (Consultants of Copper8) five ambitions for the existing building complex that needed to be renovated.

By asking for ambitions, the specific requirements and conditions what normally are given were open for discussions, suggestion and ideas. To facilitate these discussions Anouk van der Have (2015) explained in her interview that the experts on the market were invited and asked to co-create and co-

design a building that fitted within the boundaries of the five ambitions. The five ambitions that are formulated by Alliander and the consultants of Copper8 are:

- It should fit in with the new way of working, hence, flexible working environment for at least 1,550 employees: 'Nieuwe Werken';
- Maximising circularity within the design and building process;
- Energy positive building complex;
- Strengthen the relationships with the surroundings;
- Co-creative and Integral design approach.

During the process of defining the five ambitions of Alliander, intensive collaboration between multiple actors of different disciplines (architect, real estate developer, constructer, technician, interior architect, and urban planner) were involved to formulate and ask the right questions. In fact, Eugenie Knaap (2015) and Anouk van der Have (2015) both explained in their interviews that Alliander did not develop their own list of conditions and formulated the question, it was the market that gave context within the scope and boundaries of the five ambitions. This approach was emphasised on co-creation between multiple actors within a collaborative system.

It was clear that Alliander and consultants of Copper8 stimulated an iterative process to involve multiple actors, especially the experts of the market, to understand what the 'real' needs of the user/client (Alliander) are that need to be fulfilled. The case was focused on an intensive collaboration between private, policy and user. However, universities, other education institutions or specialised research institutions, which are categorised as the research actor network, were not involved in this case.

The high involvement of experts through market consultations have ensured that the whole design & build process was based on value creation. This was done by integrating the entire value chain and enhancing co-creation to develop an integral design that would represents the strategy of Alliander (Anouk van der Have, 2015). This was possible, because Alliander as client and user was open and transparent towards all their actors to get input how things could be done. Furthermore, for specific occasions, like fire safety by using unusual building materials (e.g. waste wood for the facade), the fire department and the local government were approached to get a permit, which was also an unusual occasion for them.

This co-creative and integral design approach resulted in a circular office where 83 percent of the five old offices were kept intact to be reused as offices on the building complex. These buildings were again connected by a 'greenhouse' with an iconic 'floating' and 'wavy' roof that made the office energy positive and regulated the climate within the building; this fulfilled one of the ambitions. The building materials for the "greenhouse" as a new building was made out of 80 percent of recycled/circular materials.

4.2.1 Circular Building Process: Collaborative Ecosystem

The Circular Office of Alliander is a co-designed building that was being developed by stimulating co-creation which resulted into an integral design. Therefore, Alliander provide the experts on the market five with defined ambitions and that corresponded with the company's sustainability/circular vision. This co-creative approach and the way of defining the tendering assignment was unique and needed a different plan of approach to realise this project. This 'new' approach had led to the need to develop new innovative solutions and forms of collaboration. What Alliander did, as stated by Thomas Rau and cited by Marc Doodeman (January 2014) in an online article for Cobouw.nl was: *"the company (Alliander) did not asked for a product, but for a process"*.

To understand what this meant for the whole project in which the process is seen as a *Circular Building Process as an Ecosystem,* Table 13 summarised the within case analysis of the Circular Office of Alliander. The analysis of each phase is elaborated in the next paragraphs.

Table 13: Summarised Within Case Analysis Circular Office Alliander.

(Pilot) Case	Circular Office Alliander	
Full Ecosystem approach	No	
Intensity Collaboration	High	
Envisioning Phase		
Circularity	Reuse of Materials	
Future Vision	'Use what can be reused' and the five ambitions: 1) Flexible working environment, 2) Highest possible circular building, 3) Energy positive building, 4) Strengthen relationships with the surroundings, and 5) Integral design approach	
Setting the Stage	Third independent party involvement (Copper8) to translate ambition and vision for tendering.	
Circular Shared Value	Vision and Ambition as designing criteria Value creation: - Social: Involve neighbour companies (e.g. IKEA) to share energy consumption and invest together in renewable energy (e.g. Solar Panels). - Economic: Resource Depot and Energy Positive - Ecologic: Adding value for the surrounding environment this include a bats hotel, air-purifying plants, and use of grey and rain water to flush.	
Selection Procedure	Only applicable as a consortium: competition based; best match and synergy in line with the ambitions.	
Co-creation & Exploration Phase		
Degree of Actor Involvement	From the start of the design process Design With Users	
Collaboration Approach	Participation approach:	Inhalation Dominated
	Coordination approach:	Middle-Out
	Innovation-Mechanism:	Mode of influence: Mediating
Experimentation Phase		
Discovery	Integral	
Business Development	Circular Product Design:	Slowing
	Circular Business Model:	Hybrid
Execution Phase		
Translation of Solutions	Make an inventory list of what could be reused from the old building in the new building and categorise accordingly. Preserve resources and materials by thinking also to reuse them differently than its original function by 'just-doing- it'.	
Building as Resource Depot	Yes, resource building passport is being developed.	
Monitoring & Evaluation Phase		
Learning	Trial-and-Error	
Next Practice	Yes	

4.2.2 Envisioning Phase

As mentioned, this (pilot) case was fully focused on co-creation. The main focus of the assignment was to reuse materials and products as much as possible in their new office. One of the main questions that project coordinators of Alliander asked themselves was: *"Why throwing away five-year-old toilets and replace them with new one if they are still functioning?"* For them this felt not right, because buying new ones has again its impact on the environment (Eugenie Knaap, 2015).

By asking themselves these kind of questions, awareness was being created within the company. This awareness involved users and were intrinsic motivated to achieve their defined visions for their new office. The focus of this circular building project was on "use what can be reused" and on the fact that the building should generate more energy than needed (Eugenie Knaap, 2015; Marc Doodeman, January 2014).

To make their vision concrete for the market, Alliander teamed up with the consultants of Copper8 that had an independent role to facilitate the envisioning process. Their role was steering and helping Alliander to translate their vision into ambitions by involving the experts on the market for their perspectives and expertise without designing anything at the very beginning. Therefore, the consultants of Copper8 used their step-by-step tendering process framework that is being developed and published by Cécile van Oppen and Koen Eising of Copper8 in 2012 (see Figure 21): 1) Vision Forming, 2) Question definition, 3) Selection phase, 4) Dialogue, and 5) Tender phase.

	1. Envisioning	2. Defining Question	3. Selection Procedure	4. Dialogue	5. Awarding
Context	Functional Question	Defining ambitions	Refining ambitions (static)	Refining ambitions (dynamic)	Synergy between multiple disciplines of the market
Process	Involve market	Involve internal organisation	Connect multiple disciplines within the market	Trust between client and market (both ways)	Trust between multiple disciplines
Finance	Define boundaries (static)	Scope financial model (dynamic)			Assess scope and boundaries

Figure 21: Copper8 Tendering Process Step-by-Step (Cécile van Oppen and Koen Eising, 2012).

By following the iterative process between Alliander and the consultants of Copper8, the first 2 steps are about the development of the five ambitions as criteria for the office to put it on the market (Eugenie Knaap, 2015; Anouk van der Have, 2015): 1) Building Circular, 2) Future proof working environment, 3) Develop a relationship with the neighbours and surrounding environment, 4) Energy positive location and 5) Emphasise integral approach.

For the future vision of Alliander, to reuse as much as possible, build an energy positive building and enhance circularity; co-creation and integral design were the essential keys of the whole project. By emphasising on co-creation and integral design Alliander asked to design a process instead of a design of a building. For this purpose, no certificate like BREEAM was used and no scheme was made at the beginning of the process in order to enhance flexibility and creativity (Anouk van der Have, 2015).

The above setting of the stage was essential for the selection procedure, especially, for the creation of circular shared value. The assignment of the Circular Office was only applicable for a consortium, which is a team of design experts from different disciplines; architect, interior designer, installer/engineer, landscape designer. This emphasises the co-creation and intensive collaboration between multiple experts in the field. One of the conditions was that the consortium agrees to follow and share the given vision and ambitions (Marc Doodeman, 13 January 2014). This resulted into twelve applications who

had the chance to pitch their ideas, their intentions and its synergy between the actors within a consortium, as explained in an article of de Trouw by Cokky van Limpt: *"Duurzame overjas voor oud kantoor"*, 11 February 2014. In the end, three consortia were selected for the final dialogue between all the involved actors.

During the final dialogue, the three consortia together, even though they were competitors, had on regular basis a meeting with Alliander to discuss and refine their ideas and how they would achieve the vision and ambitions set by Alliander (Anouk van der Have, 2015). These meeting sessions varied from plenary sessions to individual sessions to go more into details. This created a very competitive but cooperative environment. Competitive because they personally knew with whom they were competing and cooperative because it drove the consortia to give their all (Cécile van Oppen and Koen Eising, 2012). Alliander did choose a consortium that matched best with the ambitions and vision to start this circular project.

4.2.3 Co-creation & Exploration Phase

As described by Frank de Groot in his article *"Circulair en energieleverend herontwikkelingsproject"* published in the *Energiegids* of 12 December 2014, this circular project was mainly focused on co-creation and was categorised as a co-creative project guided by the principles of CE with its main emphasise slowing the resource loop by reuse (i.e. repairing/cleaning, upgrade and remanufacturing) as much as possible. They did not only involve their stakeholders (i.e. suppliers, contractors, policy) at the very beginning, but also their surrounding neighbours (i.e. local firms/services) and users (i.e. employees) to make a 'complete' design proposition. This proposition took into account what the potential benefits would be for the employees, the economy and the surrounding environment. By involving all the stakeholders and users actively to understand their needs, the potential benefits could be found for circular design strategies that would fulfil them.

During the whole project, the involved stakeholders continuously monitored and evaluated their activities and design strategies by keeping to ask themselves the questions if things could be done better and more circular (Anouk van der Have, 2015; Frank de Groot, December 2014). For example, very late in the process of the project the consortium decided to change the climate system into another one, because the latter could improve significantly the quality, comfort and energy management (Eugenie Knaap, 2015).

Another example of a co-creative approach that showed its adding value was, as mentioned earlier, the 'floating' and 'wavy' energy-rooftop that connected the five existing buildings and created an atrium with an intermediary space between the buildings. The decision to make a 'wavy' rooftop instead of a straight rooftop was, because it would benefit the use of airstream as energy source more efficiently. This innovative system solution was achieved because of the very early involvement and collaboration between the architect and the installer (Eugenie Knaap, 2015; Anouk van der Have, 2015; Frank de Groot, December 2014).

Due to the co-creative approach, the stakeholders and the users were stimulated to develop innovative solutions to match certain needs. This iterative process and intensive collaboration between stakeholders and users assumed that the whole participatory process and degree of involvement was based on the collaborative design process *'design with users'*. It assumed as well that the participation approach was *'inhalation dominated*', because they actively engaged the user and stakeholders to align their needs before a fitting solution was provided.

The innovation-mechanism, however, for this Urban Living Lab network is less applicable as categorised by Leminen (2013), because within the circular building process there was no clear hierarchy between the actors. The role of the experts and users along the process was focused on

fulfilling the needs as best as possible through continuous monitoring and evaluating the work in progress. As some examples show in this case, it seems that the process was flexible for adjustments where top and bottom were interlinked in several ways (i.e. upstream, downstream and side-ways), hence, a *'middle-out'* approach. This way of coordinating the innovation process, links with the middle-out approach mode of influence *'mediating'* in which the stakeholders can adapt technologies, strategies or processes that fit best in the given setting (Janda and Parag, 2013).

4.2.4 Experimentation Phase

As stated earlier by Thomas Rau, Alliander asked for a process instead of a product, which was unique in the building sector. It was even considered as a journey full of uncertainties with no clear final design/end goal that resulted into a circular building. Working this way means managing your uncertainties, but also creating space for flexibility to stimulate creativeness. In other words, see uncertainties as challenges to do things differently (Anouk van der Have, 2015; Marc Doodeman, January 2014). As Anouk van der Have (2015) also stated in her interview (translated from Dutch): *"It takes time and courage to go out of your comfort zone in order to do it differently than the usual/traditional way".*

Managing uncertainties as challenges for experimentations, triggered the co-creativity and the development of an integral design by continuously challenging the experts during the building process. This meant for the consortium a repetitive cycle of re-evaluating and assessing the building activities with the stakeholders and users back and forth with the set ambitions and vision, and making adjustment and changes in the process if needed or was favourable. In other words, continuous refinement of the designs through co-designing, testing and repeating until satisfied with the end results within the given time (milestones) and available money (budget).

According to the way the circular office was designed and build, the main design strategy, as mentioned early, was based on slowing resource loops by extending the product-life of products through. The additional ambition of becoming energy positive is categorised as a hybrid circular business model strategy that combines slowing and closing resource loops in the used and produced products. Slowing in the sense of extending the product value by reusing materials and products, making the building a resource/material depot, and encouraging sufficiency by using energy as much as needed. Closing in the sense that the energy surpluses can be shared with local firms as a form of an industrial symbiosis.

4.2.5 Execution Phase

The case of Alliander was focused on co-creation and integral designing. To be sure that this approach was maintained, regular meetings were organised with the stakeholders to put emphasis on fulfilling the needs by asking relevant CE related questions to the experts in the field (Anouk van der Have, 2015). Therefore, by co-creating with the stakeholders and users, feasible integral system solutions could be developed that should answer these questions. However, from tendering to design to execution there were still flaws in the designs that were only discovered during its execution. This affected some decisions during the execution phase, like changing measurements or recalculations. Despite the fact that the tendering and the final design was innovative, the execution was not that different from the traditional building process, which was execute the design by starting the demolition and then (re)build the new office. As Eugenie Knaap (2015) stated, after the design they just started with the execution and discovered some flaws in the design in which the measurements and calculation were not accurate. This led to the decisions to adjust it or change products or materials, which could be costly and could take more time than planned (van Hal and van Bueren, 2012).

The main theme of the project was to reuse as much as possible, the translation of solutions of the execution phase was also focused on this principle and co-creation. They were experimenting and

thinking about new possibilities of reusing products differently than its original function to preserve resources by 'just-doing-it' (Eugenie Knaap, 2015), for example, collecting old pallets from the waste treatment facility to use it as building material for the façade instead of it being used as fuel to generate energy. They also made an inventory that listed all the products and building materials of the 'old' buildings on the complex that could be reused in the new office building. They stated that this project realised a reuse percentage of 86% of the 'old' office building materials and products by actively collecting all the 'old' materials and separating them on-site according to its usage for the new office building[8]. Some examples were reusing 'old' toilets, refurbishing old ceiling tiles, using old working outfits as isolation material and granulating demolition waste to make concrete out of it for the floor.

Next to the 86 percent of reusing old building materials and products, 80 percent of other building materials and products were being (re)used according to the principles of CE and were accounted in a resource building passport. This is an elaborated document about the materials that are being used, the amount of these and where they can be found (Eugenie Knaap, 2015), which might be valuable for future businesses. By documenting all the materials and the inventory of the old building materials and products used in the new office building, they started to see a building more as a resource depot.

4.2.6 Monitoring & Evaluation Phase

This case has shown that circular buildings can be beneficial by asking for a process instead of a product/building. Therefore, all the actors had the flexibility to design their own circular building process according to the local settings and circumstances.

The monitoring & evaluation phase of this case was based on *'trial-and-error'* learning, by continuously asking the consortium on a regular base to assess the ongoing working progress and if things could be done better or even differently. This resembles in a way with the Japanese *Kaizen* philosophy to strive for an excellent operational process to get the best results out of it, hence, the five ambitions of Alliander. This gave the experts and consortium the flexibility to use their knowledge and creativity at its fullest within a co-creative setting. This concept has proven that not the financial focus is the key for success, but designing the process that emphasise co-creation and integral approach within a value chain are the key for success (Cécile van Oppen and Koen Eising, 2012). This is also what Eugenie Knaap (2015) made clear in her interview (translated from Dutch): *"Co-creation and integral design are key ingredients to build and succeed circular buildings"*.

To conclude, the main characteristics of this case are:

- Develop a vision through intrinsic motivation and translate that into ambitions to make it concrete;
- Stimulate multidisciplinary collaboration by preselecting a design team or a consortium that are committed and open for co-creation to follow the set vision and ambitions;
- Create trust, openness for discussion, and transparency;
- Create no hierarchy between client and contractors. Be flexible and open for new insights and raise the bar of ambitions if needed;
- Setting definite boundaries and high ambitions to make clear what the 'playing field' will be for the involved stakeholders;
- Choose a selection method that prevent 'tick-boxing' behaviour of the contractors;
- Make an intensive inventory of what can be reused directly and categorise them for the new situation;
- Develop a resource building passport to know what is being used, how much is used and where it can be found for potential future businesses.
- Trial-and-error and face uncertainties to strive for an excellent operation process towards circular buildings.

[8] VolkerWessels and partners of the Alliander Project created a short movie about the building process with some insights and explanation how it was executed (https://www.youtube.com/watch?v=3hciWv9aF8w).

4.3 Cradle-to-Cradle City Hall Venlo

In Table 14 the overview of the affordance flows and value generation between the involved actors of the Cradle-to-Cradle City Hall Venlo is presented. Within this overview the flows of each actor are analysed what they provide or get from the collaborative ecosystem.

Table 14: Mapping the actors and overview of the affordance flows and value generation of (pilot) case Venlo according to the conceptual Circular Building Process as a collaborative ecosystem

Cradle-to-Cradle City Hall Venlo		
Client	Municipality of Venlo	
Main Contractors	Kraaijvanger Architects, Laudy/Ballast Nedam NV	

Private	• Construction Management: BBN Advisors
	• Housing Advisor: Veldhoen & Company
	• Installation Advisor: Royal Haskoning DHV
		• Cradle-to-Cradle: C2C ExpoLab
		• Subcontractors:
		  ○ Balast Nedam Foundation
		  ○ Volker Steel and Foundation
		  ○ Tes Installations
		  ○ ENVO Installations

Policy	• Municipality of Venlo • Province of Gelderland	
Research	• C2C ExpoLab • Pr. Dr. Michael Braungart's Institution • Eindhoven University of Technology	
User(s)	• Employees of the Municipality of Venlo • Citizens of Venlo	
Type of Tendering	European Tendering Procedure	
Type of Contract	Design & Build	
Overall Circularity	Inspired by Cradle-to-Cradle elements categorised in the following themes: Enhance Air and Climate Quality; Integrate Renewable Energy; Define Material and their intended pathway; Enhance Water Quality.	
Actors/Stakeholders	**Input**	**Output**
Private	State-of-the-art C2C Technology and Research insights (Enabling Knowledge), multidisciplinary design team (Enabling Potential Economic Value and Enabling Knowledge)	Resource/Material Depot (Enabling Environment) C2C-Certificated components and products (Enabling Environment and Potential Economic Value)
Policy	Policy advice (Enabling Knowledge), C2C defined ambitions (Enabling Knowledge, Social & Cultural and Potential Economic Value) and EU & Regional Funding (Enabling Funding)	Facilitating the region C2C goals (Enabling Environment), best practice case (Enabling Social & Cultural, Economic and Environment), and open, transparent and accessible (Enabling Social & Cultural Value)
Users	Vision and Ambitions (Enabling Environment, Potential Economic Value, Social & Cultural Value) and local funding (Enabling Funding)	Comfortable and Healthy work environment (Enabling Environment and Social & Cultural Value)
Research	Sharing knowledge, technology and linking parties for projects (Enabling Knowledge and Potential Economic Value), and technical & environmental input for academic research (Enabling Knowledge	Technology and Environmental Research (Enabling Environment)

The third case is the Cradle-to-Cradle City Hall of Venlo. This case is a unique project, because the City Hall is one of the iconic Cradle-to-Cradle Projects in the region of Venlo. Venlo is representing itself as a Cradle-to-Cradle hotspot and also gets a lot of exposure around the world. It is even considered as the European capital for Cradle-to-Cradle city as explained in the magazine *"Stedebouw & Architectuur"* issue December 2012 in the article of Wijnand Beemster: *"Venlo Europese hoofdstad Cradle to Cradle"*. The key driver in the area is based on the principles of Cradle-to-Cradle this was visible in the way the tendering process of the City Hall was designed.

The tendering process was recognized by its innovative way the building was designed. It was based on the idea that a building is designed by its users, residents, culture and place, and the adaptability of the building for future innovations and continuous improvements at all scales (see *"Case study: Venlo City Hall"* done by the company *C2C ExpoLAB* (a training and knowledge centre) in 2014). Therefore, the municipality of Venlo, together with *C2C ExpoLab,* chose for another order of the tendering procedure by asking the architects for their vision that would match with the Cradle-to-Cradle vision and ambitions of Venlo. The ambitions for the City Hall was based on the conditions that it should create a pleasant and healthy workplace combined with sustainable innovations for the employees of the municipality of Venlo. The building should represent as well the agricultural and logistic traditions of the region of Venlo, and the openness, transparency and accessibility of the municipal organisation (C2C ExpoLAB, 2014). As described in an online article of Michel Weijers (January 2011) *"Stadskantoor Venlo op en top C2C",* this approach took the municipality of Venlo more time in order to find the right stakeholders to form the design team that were committed to fulfil their ambitions.

During the tendering procedure five visions out of more than fifty candidates were selected and started the kick-off meeting. During this meeting the selected candidates had the chance to refine, finalise and submit their final vision supported by the 'frontrunners' in the field of Cradle-to-Cradle within two weeks. The commission assessed them according to their selection criteria and awarded the project to Kraaijvanger Architects. The decisive elements of their vision were (C2C ExpoLAB, 2014): 1) living green façade that cleans the indoor and outdoor air, 2) the use of materials that can be recycled afterwards, and 3) an energy positive building by generating more renewable energy then the building needs.

After awarding the project, Kraaijvanger Architects started the design process with a pressure cooking. The role of C2C ExpoLab was important as intermediary to connect different advisory parties together to form the design team. This design team included the private, policy and research parties and they worked together with the users.

The pressure cooking stimulated Kraaijvanger Architects to collaborate intensively with the user and stakeholders to develop an integral design. This iterative process between the user and stakeholders to align the ambitions of Venlo with the building design, created an environment that was efficient and productive. The design team, the municipality of Venlo and the contractors had their regular project meetings and monthly meetings. These monthly meetings were organised in order to monitor the process on its continuity and synergy between the stakeholders, and what the market could contribute more to the project. This was also a stimulant for the building industry to encourage them to innovate their product development towards Cradle-to-Cradle principles.

To gain knowledge to put more emphasis on Cradle-to-Cradle ambitions of Venlo, the design team decided to follow a 4-day training organised and facilitated by the Pr. Dr. Michael Braungart's Institution (C2C ExpoLAB, 2014). This training gave the design team more commitment and focus to follow the principles of Cradle-to-Cradle, however, they were aware that it was not feasible yet to build a fully Cradle-to-Cradle building. Additionally, to convince the stakeholders that the living green façade would function as an air cleaner, the design team also investeded in extra research. This research was carried out by the Eindhoven University of Technology.

4.3.1 Circular Building Process: Collaborative Ecosystem

The City Hall Venlo took a different approach of circularity, which was the concept of Cradle-to-Cradle as guideline for designing and building. It is part of CE thinking that put emphasis on either the biological or the technical metabolism. Emphasising this thought, the municipality of Venlo strived to become the Cradle-to-Cradle Hotspot. Given their vision and ambitions for the region of Venlo a fitting City Hall was obvious. To make this visible and tangible they asked the architects for their vision that would match the vision and ambitions of Venlo.

Table 15: Summarised Within Case Analysis Cradle-to-Cradle City Hall Venlo.

(Pilot) Case	**Cradle-to-Cradle City Hall Venlo**	
Full Ecosystem approach	Yes	
Intensity Collaboration	High	
Envisioning Phase		
Circularity	C2C-certified Materials	
Future Vision	Cradle-to-Cradle defined ambitions for an innovative and sustainable building that provides a comfortable and a healthy working environment.	
Setting the Stage	Third party involvement (C2C ExpoLAB) to set up and facilitate the ambitions of the municipality for their new building.	
Circular Shared Value	Vision Development Assignment Value creation: - Social: An iconic building at the Meuse designed for its users and residents, culture and place. - Economic: Resource/material passport and investments in Cradle-to-Cradle products. - Ecologic: create adding value by using renewable sources and apply appropriate materials for both the biological and the technical cycles.	
Selection Procedure	Design a vision for Venlo based on Cradle-to-Cradle principles: competition based, finals a two-week kick-off meeting facilitated by C2C ExpoLAB.	
Co-creation & Exploration Phase		
Degree of Actor Involvement	From the start of the design process Design For Users	
Collaboration Approach	Participation approach:	Inhalation Dominated
	Coordination approach:	Top-Down
	Innovation-Mechanism:	Utiliser-Driven
Experimentation Phase		
Discovery	Integral and Cooperative	
Business Development	Circular Product Design:	Closing
	Circular Business Model:	Closing
Execution Phase		
Translation of Solutions	Solutions were used for the project if it was certified by an official Cradle-to-Cradle auditor and proven that the products or materials functioned accordingly.	
Building as Resource Depot	Yes, stimulate producers and suppliers to focus on future value of materials after its usage by stimulating bookkeeping for the used materials in the building.	
Monitoring & Evaluation Phase		
Learning	Trial-and-Error	
Next Practice	Yes	

An integral design is necessary, which means collaborating with multiple actors. This is what Kraaijvanger Architects together with the municipality of Venlo and C2C ExpoLab have done during the building trajectory. To understand this process as a *Circular Building Process as an Ecosystem,* Table 15 summarised the within case analysis of the Cradle-to-Cradle City Hall Venlo. The elaborated analysis of the four phase are described in the next paragraphs.

4.3.2 Envisioning Phase

For the tendering process the municipality of Venlo asked the architects to present a vision as assignment, specific related to Cradle-to-Cradle. Within this vision it should be clear that the emphasis was both on the biological and the technical metabolism. The design of the products should explain the management of the input and output flows of the materials of the building. This is crucial, because according to the principles of Cradle-to-Cradle, 'waste equals food'. Referring to the biological metabolism, the biological nutrients can be preserved to design the products in a way that it can again re-enter the biosphere safely. For the technical metabolism this means that the products must be designed to close loops within a system in order to prevent that the technical nutrients will re-enter the biosphere.

By following the principles of Cradle-to-Cradle for the entire building of the City Hall Venlo, its circularity and future vision was based on this. In addition, the municipality of Venlo as user and client also wanted to be open, transparent and accessible for the citizens of Venlo. For its employees the central theme of the building was to create a comfortable and healthy working environment, combined with innovative and sustainable solutions/systems (C2C ExpoLAB, 2014).

Taking a broad approach, by asking for visions that fitted the ambitions, triggered architects to use their expertise and creativity at its fullest. To select the design team, the assignment of the municipality was competition based and more than fifty candidates participated. The five best visions were selected for the kick-off meeting facilitated by the local Cradle-to-Cradle training centre and consultancy company *C2C ExpoLab*. During the meeting they were also supported by the 'frontrunners' in the field of Cradle-to-Cradle. After the kick-off, these five candidates were given the assignment to refine and complete their final vision within two weeks.

These two weeks were ideal to develop a circular shared value by co-designing with multiple actors. That was also what the winning design team Kraaijvanger Architects had done to develop their plan of actions through co-designing with multiple actors that would be involved in the project and developed an integral design. According to the article of Michiel van Raaij *"Meer, meer, meer!"* in the online magazine "Architectenweb" of July 2013, what they had done was designing a process instead of a building. This was a good way to involve multiple actors and created circular shared value. This resulted, as mentioned earlier, in a vision that incorporated elements as the living green façade that cleans the indoor and outdoor quality, use of recyclable materials, and a building that generates renewable energy.

This free and creative setting, in which the vision and ambitions of the municipality of Venlo were the only conditions that should be met, created a comforting environment that stimulated cooperation and co-creation. It enhanced as well the freedom for the design teams to design or plan their process according to their own ideas and visions. By creating such a setting as a client, design teams felt responsible for their own ambitions that they wanted to put in practice. For the client it created more flexibility to steer the design and to focus on what they really wanted based on vision pitches of architects instead of selecting for an already completed building design (Michel Weijers, January 2011).

4.3.3 Co-creation & Exploration Phase

This project was awarded to Kraaijvanger Architects, because they presented a plan of action that emphasised an integral design as design process instead of a designed concept building. It was also their unique selling point to involve multiple stakeholders and users along the process. Therefore, Kraaijvanger Architects organised what they called 'Atelierdagen' (Michiel van Raaij, July 2013), which is familiar with workshop days. To invite all the stakeholders and users who need to be involved they settled, for a couple of weeks, in a bungalow park nearby the construction site (Michiel van Raaij, July 2013). This way of designing a building led to the opportunity for Kraaijvanger to involve all the stakeholders and implement directly the ideas with the design team. This improved their efficiency because they could adapt the local needs quicker. They also asked their producers, suppliers and contractors at the beginning of the design process to already think about their product end-of-usage design (Edward Timmermans, 2015). According to Edward Timmermans (2015) of Kraaijvanger Architects, this made it possible to introduce the resource/material passport to let them think as well about the value of their resources/materials at the end of its usage.

Besides the 'Atelierdagen', to involve multiple stakeholders as efficient as possible, the design team also decided to get more knowledgeable with the philosophy of Cradle-to-Cradle. Therefore, they organised with the Pr. Dr. Michael Braungart's Institution a 4-day training. During this 4-day trajectory the design team concluded that they needed to set boundaries to focus on several themes of Cradle-to-Cradle within the project, because fully Cradle-to-Cradle was in practice not feasible. The design team decided to focus on four themes each with its desired results (see Table 16 for details).

In the beginning of the design process the degree of actor involvement was to get a better understanding what the user wanted and find the right stakeholders to fulfil them. In the design process the involved actors were focused on designing and developing a Cradle-to-Cradle building on behalf of the users, hence, a collaborative design process based on *'design for user'* approach.

Table 16: The four Cradle-to-Cradle defined themes and its desired results (derived from (C2C ExpoLAB, 2014))

Cradle-to-Cradle theme	Challenge	Desired Results
1. Enhance Air and Climate Quality	Using the building to enhance indoor and outdoor quality, and the use of climate change gases to enhance the air quality in the surrounding environment.	- Improved outdoor air quality. - Improved indoor air quality. - Increased biodiversity. - Aesthetically appropriate in its environment. - Increased labour productivity.
2. Integrate Renewable Energy	Energy positive building by using renewable energy.	- Renewable energy only. - More renewable energy generated then needed. - Possible to integrate innovative energy solutions during time. - Energy-efficiency to integrate renewable energy rather than to reduce fossil fuel use. - Transparent energy-system (physically and virtually).
3. Define Material and their Intended Path	Apply materials and products that are appropriate for both biological and technical metabolisms, without the loss of quality.	- Appropriate for biological or technical cycle. - Cradle-to-Cradle certified. - 'Waste equals food'. - Add values for the users and the environment.
4. Enhance Water Quality	Using the building to improve water quality, and becomes health for the biological metabolisms.	- Enhance water quality. - Extract nutrients from (waste)water. - Transparent water system (physically and virtually).

The design team, the municipality of Venlo and the contractors organised in addition to their regular project meetings also monthly meetings. These monthly meetings were organised in order to monitor the process on its continuity and synergy between the stakeholders, and what the market could contribute more to the project. This was also a stimulant for the building industry to encourage them to innovate their product development or product design strategies towards Cradle-to-Cradle principles, thus, closing the loops. These regular and monthly meetings were a way of collecting knowledge about the possibilities and state-of-the-art technology in the field of Cradle-to-Cradle that would fulfil the requirements and needs of the user/client, hence, the municipality of Venlo. By engaging stakeholders for acquisition and gathering knowledge externally for fulfilling the Cradle-to-Cradle vision and ambitions for the City Hall of Venlo this can be assumed to be categorised as a participation approach that is *'inhalation dominated'*.

To coordinate this project, the municipality of Venlo asked the architects to present a vision that was based on the Cradle-to-Cradle hotspot ambitions of the region. By asking a specific assignment, the architects were bounded on the principles of Cradle-to-Cradle. This can be assumed as a *'top-down'* oriented approach, because there is a clear hierarchy between the architects and the municipality. The latter decided that this project should be achieved by strictly following the Cradle-to-Cradle principle and the architects have to come with a vision proposition that fits. Nonetheless, it is still an iterative process between the client and design team in order to realise an integral design that fits within the philosophy (Michel Weijers, January 2011), because one of the Cradle-to-Cradle principles is to stimulate iterations. Overall, the client still had the direction and control, which is centralised, to steer the design process for their City Hall. To convince the client as supplier or producer to integrate certain systems or products in the design that will function as described, investing and doing extra research can be decisive. This was also done by the design team for the living green façade in collaboration with the Eindhoven University of Technology (Michel Weijers, January 2011).

The municipality of Venlo as one of the main policy actors was responsible to embed a circular model as leading guiding principles. For the stakeholders this meant that they were given the option to make adjustments within their business activities to adapt these guiding principles (Edward Timmermans, 2015). If a stakeholder did not want to adjust their business activities or was not committed, another stakeholder was selected (C2C ExpoLAB, 2014). Therefore, the stakeholders were given the opportunity to develop and create Cradle-to-Cradle certified ideas, concepts, or prototypes that could be validated and tested on a building scale. This means Cradle-to-Cradle certified product acquisitions occur and external knowledge is being used for the development, which were selected and approved by a centralised authority (i.e. the client and design team). This centralised selection procedure (top-down), in which companies were given the opportunity to promote their Cradle-to-Cradle businesses (inhalation dominated), give the expression that the City Hall Venlo can be assumed as a Living Lab network accordingly to a *'utiliser-driven'* innovation mechanism.

4.3.4 Experimentation Phase

For this project the circular building process was based on designing a process instead of a building. This approach triggered an integral design where multiple stakeholders were cooperating. It was cooperative and not co-creative, because one of the main conditions was that the materials, resources and products needed to be Cradle-to-Cradle certified before it would be applied in the final design. It was not co-designed with the user together, but it was responsibility for the company self to get this certification for their products and materials on behalf of the user. If a company did not have the required certifications, the design team was obliged to search for other companies, alternative products or materials that were certified (Edward Timmermans, 2015). Thus, a cooperation between producers, suppliers, design team and client with the selected products or systems were the basis to develop an integral design.

Even if the product is Cradle-to-Cradle certified it is still not guarantee that it will be used. As an example, Edward Timmermans (2015) told in his interview that they selected a company to deliver the roofing that was Cradle-to-Cradle certified, but in the end they rejected this type of roofing. It was rejected because, the product dissolves if it was exposed to stagnant water over time. This kind of feedback or observations helps and challenges the producer or supplier during the experimentation phase to be critical. It was about re-evaluating the activities back and forth with the set ambitions and vision. By experimenting, refining and adjusting the products or materials producers and suppliers could make for sure that it would deliver the functional performance as designed.

The emphasis on Cradle-to-Cradle principles as leading theme for the new City Hall of Venlo, the main design strategy and focus of the products were already fixed and should close the loops of resources. Therefore, the main focus of the way of doing business was to select products and materials strictly on official Cradle-to-Cradle certified. Additionally, as Edward Timmerman (2015) stated, *"it is important to think in terms of generating future values after its usage and capture it in a business model, like, a resource building passport".* This give the assumption that the business model strategy to do business for this case can be seen as a model that also focuses on closing the loops. However, how they bring this in practice in a business model was not clear, except for the Cradle-to-Cradle certified product acquisitions, they were still struggling with it and were still experimenting with the idea of the resource building passport.

4.3.5 Execution Phase

As mentioned several times, the building process in this case focuses on using Cradle-to-Cradle certified products. This stimulated innovations, but could also be seen as a constrain for companies to get certified. During the execution phase, it is about the translation of solutions and make them applicable for the completion of the building. For this case this means, if a company had an idea or concept that had the potential to be Cradle-to-Cradle, it needed to be certified to get proven as Cradle-to-Cradle before it would be used. To get a certification for a certain product or material, an official Cradle-to-Cradle audit must be executed, which can be costly. Especially, when more products or materials need to be certified, because each product or material must be certified separately (Edward Timmermans, 2015). Nonetheless, once certified, it can give the company a competitive advantage.

It was challenging for companies and experts to get their products or materials certified, but as stated before, they got the opportunity to convince the design team to use their product or materials. If it was not yet certified the design team gave them the time and opportunity to get it certified. However, if it the company did not succeeded in time the design team was obliged to look for alternatives (Edward Timmermans, 2015). There were exceptions for non-certified products or materials that are necessary to use for the construction that do not have any alternative (yet) (e.g. lute for finishing seams and joints), because a functional building must be delivered within a certain timespan.

For this building project, the design team stimulated the building as resource depot to make producers and suppliers aware of the what the future value of their products or materials could be after its usage. By actively asking them to think about these values they proposed them to bookkeeping the materials that are used to get insight in potential financial prospects (Edward Timmermans, 2015). The idea of bookkeeping materials will help to think about future values of the products, but it is still executed as an experiment in which it might help actors. What it will entails and its affect over time is still uncertain, because companies cannot guarantee that they still exist if the products is on the end of its usage phase (Edward Timmermans, 2015).

The final delivery of the City Hall will not be fully Cradle-to-Cradle, because the current state-of-the-art technology in this field is still immature to achieve it. Nonetheless, to anticipate on future developments Kraaijvanger Architects and C2C ExpoLAB have incorporated a roadmap in the design

and execution process to stimulate the municipality of Venlo to continue scanning the Cradle-to-Cradle market for maintenance and future improvements. By then it should be implemented in the flexible building design to keep on striving for a fully Cradle-to-Cradle City Hall (C2C ExpoLAB, 2014; Michiel van Raaij, July 2013). This makes clear that the building is designed to close loops and is compatible with their main business model strategy that is focused on closing loops by extending the resource value.

4.3.6 Monitoring & Evaluation Phase

This case showed that a circular/Cradle-to-Cradle building can be beneficial. Therefore, the client asked for a vision and ambitions that needs to be met. To fulfil these conditions Kraaijvanger Architects designed a plan of action as a process instead of a standard conceptual product/building that was adjusted for Cradle-to-Cradle. This means that the architects had their freedom to interpret and design their own circular building process that met the local ambitions, settings and circumstances.

The learning process was based on *'trial-and-error'*, because the use of only Cradle-to-Cradle certified products and materials were compulsory. It was necessary to asses and develop various products to meet the criteria, test the viability on its function or usage as building material and refine or adjust it if needed or favourable. It can happen that a Cradle-to-Cradle product or material that is being used, looks promising at the beginning, but overtime it can happen that it is not functioning accordingly and needs to be replaced. These scenarios are costly and need to be avoided, like the example that was given about the dissolved roofing if exposed to stagnant water.

This means that even if you want Cradle-to-Cradle products or materials, it will not always guarantee that it is viable to use, thus, extensive testing and redesigning through trial-and-error is recommended. This can be managed by continuously re-evaluating, monitoring and testing the products for flaws. This was also what Kraaijvanger Architects had done by organising monthly and regular project meetings. To hold your vision as a client is important as well that your policy and regulation embed a circular model as guiding principles. This also applies for the stakeholders, by making them responsible for their business activities. If they did not comply with the ambitions, the consequences were clear; they could not contribute to the project.

To conclude, the main characteristics of this case are:

- Use your vision and ambitions as assignment to the market;
- Competition based selection procedure motivates architects to use their creativity and knowledge at its fullest;
- Embed a circular model in your policies and use it as guiding principles during the process;
- Form a design team that is committed to follow your vision and ambitions, and have the right mind-set to deliver good results;
- Set clear boundaries and conditions at the beginning of the process and continuously monitoring it with all the relevant actors;
- Make clear what the responsibilities of the actors are and what the consequences are if it does not contribute to the project;
- Certification as main driver for innovation;
- Bookkeeping of materials being used to make future value more concrete.

4.4 Finding the Patterns: Cross-Case Analysis

Comparing the three cases (see Table 17) it becomes clear that they all started with a certain vision or high ambitions to the market as an assignment that is being awarded to an already formed design team or consortium. The way CE is being used in these cases are slightly different, because of their interpretation of this concept. Living Lab concepts such as ULL were also not well-known by them. They had an idea what it could be, but it was not sufficient to make well-argued opinions.

Nonetheless, the most interesting observation to state is, that the success of circular project is based on multidisciplinary design teams that are stimulated by setting the stage that emphasises cooperation or co-creation and integral design. This confirms that the first two phases of the structural elements of UTL (Nevens et al., 2013) in which setting the stage is aiming for a comfortable environment. Within the setting the stage, actions and strategies can be discussed in an 'open' and competitive based environment. A preselected design team or consortium needs to be formed to enhance integral design by selecting the relevant actors and setting the boundaries of the 'playing field' in which the vision or ambitions are the guidelines.

It is remarkable that the assignments given by Venlo and Alliander are based on asking for a process design instead of a building design. It shows that asking for a process design can capture the value and real needs of the user to develop a tailor made building design (Osterwalder et al., 2014). It can capture the value of learning, because uncertainties can be managed by trial-and-error or experimenting with solutions and get feedback for refinement or adjustment (Blank, 2013; Nevens et al., 2013). Designing a process also creates more flexibility, by not being bounded to a certain building design, and possibilities to exploit expert's and user's knowledge for creativity that entails innovation in an (open) innovation setting (Thomke and von Hippel, 2002). It is through cooperation or co-creation to develop a design towards a certain goal that needs to be fulfilled. This means as well that the whole value chain must collaborate to achieve outstanding results by improving and increasing its efficiency and develop circular operations that fit the building process (Nidumolu et al., 2009). Due to these assignments, it was competitive as well in a positive way, because knowing who the competitors are, stimulates to make full use of the available resources and expertise. Despite the fact that it stimulates competitiveness, it also stimulates the competitors to learn from each other. In the Alliander case that was focused on co-creation, the competitiveness between the competitors even strengthens its co-creativeness (Cécile van Oppen and Koen Eising, 2012).

To facilitate the envisioning phase, two out of three cases have involved a third external party, which had the role of mediator. Their role was to connect multiple parties together to form multidisciplinary design teams or consortium and facilitate the decision-making process that was of concern for the entire building process. Traditionally, it is common in a building process that project teams or design teams are formed for collaboration. However, for decision-making in the building process there is no certain actor or facilitator who make the decisions for the entire value chain. In general, actors are making decisions that only concern their role or part of the value chain, which are often cost efficiency and liability related (van Hal and van Bueren, 2012).

According to these two cases, it can be assumed that third parties should be seen as the director of decision-making for the entire building process. This is needed to make sure that the clients can focus on what they really need, stimulate user-oriented innovation and improve collaboration through co-creation (Schaffers et al., 2007; Teece, 2010), hence, the empowerment of users (Bergvall-Kåreborn, Holst, et al., 2009). This can be done by asking them the right questions, consult the markets what the possibilities are, and connect all the actors together to open up the dialogue for possible collaboration forms. This sounds familiar with the facilitative role that the *transition team* (T-Team) has as suggested by Nevens et al. (2013).

Table 17: Overview cross-case analysis of the three circular building (pilot) cases.

	Town Hall Brummen	Circular Office Alliander	Cradle-to-Cradle City Hall Venlo
Full Ecosystem approach	No	No	Yes
Intensity Collaboration	High at the beginning Medium during the process itself	High	High
Envisioning Phase			
Circularity	Design for Deconstruction	Reuse of Materials	C2C-certified Materials
Future Vision	Semi-permanent and representative building for at least 20 years with high sustainability standards (technical, experience and usage) with a limited budget.	'Use what can be reused' and the five ambitions: 1) Flexible working environment, 2) Highest possible circular building, 3) Energy positive building, 4) Strengthen relationships with the surroundings, and 5) Integral design approach	Cradle-to-Cradle defined ambitions for an innovative and sustainable building that provides a comfortable and a healthy working environment.
Setting the Stage	Multiple party dialogue to develop ambitions.	Third party involvement (Copper8) to translate ambition and vision for tendering.	Third party involvement (C2C ExpoLAB) to set up and facilitate the ambitions of the municipality for their new building.
Circular Shared Value	Performance based as designing criteria Value creation: - Social - Economic - Ecologic	Vision and Ambition as designing criteria Value creation: - Social - Economic - Ecologic	Vision Development Assignment Value creation: - Social - Economic - Ecologic
Selection Procedure	Fixed budget and high sustainability standards: Asked for a solution for their future vision.	Only applicable as consortium: competition based; best match and synergy in line with the ambitions.	Design the vision for Venlo based on Cradle-to-Cradle: competition based, finals a two-week kick-off meeting facilitated by C2C ExpoLAB.
Similarities	- Main starting point of the three cases was based on preservation of resources; - All the three cases were innovative by using vision and ambitions for tendering;		
Differences	- Alliander and Venlo involved a third party as mediator by facilitating the building process and making overarching (final) decisions; - Alliander and Venlo choose for a competition based selection procedure where they asked for a process design and not a 'completed' building design.		
Co-Creation & Exploration Phase			
Degree of Actor Involvement	From the start of the design process Design For Users	From the start of the design process Design With Users	From the start of the design process Design For Users
Collaboration Approach	Bottom-Up approach and Exhalation Dominated Innovation-mechanism: Enabler-Driven	Middle-Out approach and Inhalation Dominated Innovation-mechanism: Mediating	Top-Down approach and Inhalation Dominated Innovation-mechanism: Utiliser-Driven
Similarities	- Involving actors as early as possible in the process; - All three cases reduced resistance and support due to active involvement of actors; - All cases were tailor made.		

Differences	- Brummen and Venlo focused on behalf of the user and Alliander focused on co-designing with the user; - Alliander had no clear hierarchy between actors compared to Brummen and Venlo where it was clear.		
Experimentation Phase			
Discovery	Integral	Integral and Co-creative	Integral and Cooperative
Business Development	Circular Product Design: Slowing Circular Business Model: Slowing	Circular Product Design: Slowing Circular Business Model: Hybrid	Circular Product Design: Closing Circular Business Model: Closing
Similarities	- In all the cases, being critical but thoughtful as client/user or as stakeholder stimulated innovations; - All the cases, listened to their client/user and stakeholders and process the feedback by refining and adjusting their solutions if needed or favourable; - The way of doing business were focused on material or resource efficiency; - Integral designing is necessary.		
Differences	- Brummen and Venlo was based on providing solutions for problems and Alliander was more based on having problems that need solutions. - Venlo was cooperative because the experimentations were focused on fulfilling the needs on behalf of the user and contribute to the project and not like Alliander that co-created with the user to explore their 'real' needs to fulfil.		
Execution Phase			
Translation The Solutions	Responsibilities of the experts through contract management. Approval by client; 'best' value for the right price.	Make an inventory list of what could be reused from the old building in the new building and categorise accordingly. Preserve resources and materials by thinking also to reuse them differently than its original function by 'just-doing- it'.	Solutions were used for the project if it was certified by an official Cradle-to-Cradle auditor and proven that the products or materials functions accordingly.
Building as Resource Depot	Partly, because designed to deconstruct but no firm agreements made for a take-back system.	Yes, resource building passport is being developed.	Yes, stimulate producers and suppliers to focus on future value of materials after its usage by stimulating bookkeeping for the used materials in the building.
Similarities	- All cases were focused on executing their solutions through experimenting with creating adding value on the long term; - See buildings as a resource depot;		
Differences	- Each case interprets resource depot differently; - Alliander and Venlo developed a concept or idea to get tangible results if a building is a resource depot. Brummen did not continued with the idea of seeing a building as resource depot and fell back to their traditional business model.		
Monitoring & Evaluation Phase			
Learning	Trial-and-Error	Trial-and-Error	Trial-and-Error
Next Practice	No	Yes	Yes
Similarities	- Feedback loops and evaluations are embedded in the circular building process; - All the cases shared their results.		
Differences	- Brummen did not continued to follow the principles of CE after completion, but the end-result of the building is still CE based.		

The necessity during the co-creation and exploration phase, to involve the users and stakeholders as early as possible in the process is also clear in the three cases. The benefits of early involvement is the high influence to add value during the design process, better alignment with the real needs of the user and stakeholders, and the costs are still low for changes (Bocken et al., 2015; Feurstein et al., 2008; van Hal and van Bueren, 2012; Leminen et al., 2012). This includes the input of the neighbours (e.g. the citizens and/or local firms), because including them in the process will increase their support and reduce resistance (Mulder and Stappers, 2009). This is clear in the end results of all the three cases. First, the Town Hall of Brummen is well received and it gains a lot of exposure globally as example of an innovative building process (Maartje van den Berg, 2015). Second, the Circular Office of Alliander collaborated as well with their neighbouring companies to do big investments together that benefits them all, for example investing in solar panels that generate energy for the area. By doing so, Eugenie Knaap (2015) stated that all the companies will generate their own energy and can share with each other based on supply and demand by, for example, a Smart Grid infrastructure. This will be beneficial for all the involved companies, because it supports innovations and businesses in the area, it creates relationships between parties within the area, and it gives them the opportunity to use the available resources more efficiently and sustainably.

The new City Hall of Venlo is slightly different. In this case the neighbours were not involved directly in the process, because the municipality defined their vision what the region should represent. It needed to be an iconic building along the river Meuse that stands for the agriculture and logistic traditions of the region of Venlo. As it is for the municipal organisation, it should also represent their openness, transparency and accessibility.

The way to involve the stakeholders and user to participate and its coordination is still dependent on the circumstances and the goal of the project. In the case of Brummen the client was only involved if they agreed with the proposed design and decided if it was in line with their ambitions or not. They shifted their full responsibility to steer and coordinate the project to the experts, because the experts were knowledgeable enough to solve the problems, not only individually, but as well as a team.

The case of Venlo was clearly the opposite in which only Cradle-to-Cradle certified products and materials were allowed to be used. This is what the municipality of Venlo emphasised. If a company did not match the conditions, they were given the opportunity to try to get the certificate, but if not successful another company or alternative that got the certificate would get a contract.

The case of Alliander was more in between the two cases. Their approach was mostly based on designing a process with no clear end. It was managing the uncertainties and during the process the building would get its final form. An intensive collaboration between client, user, contractors and policy was needed to govern the process successfully. All the actors were challenged to fully use their available resources to co-create and solve the problems. This was successful, because they kept asking themselves if it could be done better and more sustainable. There was no clear hierarchy between the actors or a strict top-down/bottom-up approach, because they needed each other equally to face the challenges.

Based on the three cases, in order to coordinate and design the participatory process, it is dependent on what the client's vision is or ambitions are that need to be realised. This can be achieved by choosing different pathways; top-down, bottom-up or middle-out, and either inhalation dominated or exhalation dominated. None of these pathways can be considered as the best way to choose, but it is clear that each case is unique, need its own adaptation and should be tailor made. Maartje van den Berg (2015) stated this in her interview (translated from Dutch): *"Each circular project is unique and needs its own modification, but learn from each case, get inspired and adapt what can be useful for your project. Do not copy and paste!"*

To get inspired, adapt and learn from different cases the client, the users and the stakeholders should continuously be asking themselves what the barriers, challenges and opportunities are in order to strive for their highest ambitions. That is also what happens during the experimentation phase of the circular building process. By being critical but thoughtful all the stakeholders will benefit from it, because people can learn from each other and can improve themselves (Blank, 2013; Feurstein et al., 2008; Thomke and von Hippel, 2002). This was clear in all the three cases, but each case had another approach of striving for their highest ambitions. In the case of Alliander, it was very clear that they were critical to keep experimenting, improving and validating the design until fully satisfied, which was based on an integral and co-creative approach. This resulted in innovative systems like, for example, the 'floating and wavy' rooftop that makes efficient use of energy and could in theory generate energy.

For the case of Brummen their way of being critical was to fulfil their functional needs with a limited budget in an integral design and the take-back condition. The stakeholders became responsible for their products after it is been used for twenty years. The changing responsibilities for the stakeholders also enforced them to assess their own expertise and products in order to made a decision in what way they could preserve the value of their products when it will be taken back (Marijn Emanuel, 2015; Maartje van den Berg, 2015). This had its effect that if one of the stakeholders wanted to change their product design, the whole system design had to be adjusted to fit in.

In the case of Venlo, the Cradle-to-Cradle certificates were leading for the whole construction of the building. This mainly effected the design of the products, because the way of reasoning was based on the principles of Cradle-to-Cradle. Therefore, Kraaijvanger Architects kept asking their stakeholders why constructing activities were done that way and if it could not have done otherwise or with an alternative solution (Edward Timmermans, 2015). Additionally, they also asked if the stakeholders had thought about what the future value will be of their products and if they would be willing to pay for that. From the way how Kraaijvanger Architects embraced the circular building project, it focussed on making an integral design by cooperating with stakeholders with a Cradle-to-Cradle certificate. Cooperating in the sense that it is on behalf of fulfilling the user' needs and not co-creating with the user to explore the 'real' needs that need to be fulfilled.

Comparing the three cases for the experimentation phase, it is clear that the client and consortium must remain critical but thoughtful to maximise the end results. This not only kept the actors motivated to search for the best possible solution, it should stimulate them to share their ideas or solutions to get feedback and refine and adjust them if needed or favourable. As long as the client or consortium remain critical and give the stakeholders the opportunity to convince them why they should use a certain solution, makes a co-creation process more beneficial for them. By discussing first about solutions in relation with solving a problem, a better alignment can by then be made within the supply/value chain (Gert Jan de Gier, 2015) and the idea or solution will become more credible for implementation (Joan Prummel, 2015). This way of aligning the supply/value chain by providing a solution to solve a problem is visible in the case of Brummen and Venlo. Brummen as client asked the experts to provide them with solutions that were functional performance based in line with their ambitions and Venlo as client explicitly asked experts to provide Cradle-to-Cradle solutions that were in line with their regional vision. Alliander as client, on the other hand, had a different starting point that was based on managing uncertainties (problems) by searching for possible solutions. Therefore, they asked experts in the market what the possibilities were that could be fulfilling their ambitions.

These starting points are both viable options for understanding the user's needs and developing satisfying circular design value propositions. However, the building context and the preference is determined by either the client or the design team/consortium (Osterwalder and Pigneur, 2010). This has its effect on the way how the design process can be organised and to set milestones for a particular case. It also creates the flexibility to explore and to experiment with circular solutions that stimulates the co-creation or cooperation process between the actors, which eventually results in a unique

circular building. As Marijn Emanuel (2015) stated in his interview (translated from Dutch): *"Every design process can be seen as a 'unique' process where you can learn by doing and explore new things that can go beyond your comfort zone. It is about learning from it and make improvements each time".* This is in line with the way in which the value proposition design process of Osterwalder et al. (2014) is being described and the lean-start up methodology is being developed (Blank, 2013).

With the design value proposition clarified and circular solutions proposed by listening to your client/user (Blank, 2013), the experimentation phase is also a process of finding logical ways of doing businesses fitting the particular user/client needs (Teece, 2010). In the three cases, this is still a point of discussion and based on assumptions if the business models were refined or adjusted to make it fit for their circular building. In all the three, cases they worked with contracts in which the responsibilities and conditions were elaborated. These contracts were leading to make decisions along the value chain and during the circular building process. The elaborated context of these contracts were not explored in this research. According to the type of contracts and the vision and ambitions, and the circular building process assumptions were made in which circular business model strategy (Bocken et al., 2015) it could be categorised.

For Brummen in the beginning, it was already stated that the tender assignment was based on a semi-permanent building for twenty years. This led to both the design strategy and business model that it was focused on extending the product-life and after twenty years it would be taken back in the form of a circular business model strategy that focused on slowing product loops by extending the product value. For Venlo the same business development as Brummen is applicable, because Venlo also stated in the tender assignment that it should be a Cradle-to-Cradle building. This meant designing and constructing a building that close loops according to the principles of Cradle-to-Cradle as described by McDonough and Braungart (2010). This meant designing products, materials and services that do not harm the natural systems (biological cycle) and/or technical solutions that can continuously and safely be recycled (technical cycle) (Bocken et al., 2015; McDonough and Braungart, 2010). With this focus of the case, the business model strategy is assumed as closing resource loops by extending the value of resources. In the case of Alliander, it was about reusing materials as much as possible, which made it clear that they were using a design strategy that was emphasised on the extension of the product-life. For the business model strategy, a hybrid form was more fitting, because part of their ambitions was focused on the extension of product values and the other part focused on building a relationship with the local firms and surrounding neighbours, and making an energy positive building. For the latter part, Alliander stimulated shared investment in solar panels with some local firms and shared energy consumption by exchanging energy surpluses according to supply and demand with them, hence, an industrial symbiosis (Bocken et al., 2015; Chertow, 2007) to close loops as business model strategy.

Comparing these cases, the similarities that can be found are all focused on the preservation of resources by avoiding, preventing and minimising the use of resources while reducing the amount of waste (EEA, 2015), hence, material efficiency (Allwood et al., 2011). These three cases are in essence circular buildings that embed principles of CE. As stated before, the way of doing business is still debatable, because the contracts that are signed suggest that all the parties agree to follow vision and ambitions of the client and incorporating CE principles. In practice, it was not clear yet how it entails in a circular business model. See for example, the case of Brummen that started to follow the TurnToo business model by seeing the building as a resource depot (including EPR (Mayers, 2007; Schouten, 2014; Walls, 2006)) and estimated the financial structure for twenty years. However, after the completion and delivery they stepped away of this business model and went back to a traditional financial structure to amortise the building for forty years, not including EPR.

Looking to the three cases for their innovativeness within the building sector, they challenged the traditional mind-set by using vision and ambitions as tendering conditions. This resulted in exploring (new) user-oriented collaboration forms that manage uncertainties by stimulating experimentation,

trial-and-error learning, co-creation and creativity during the process (Feurstein et al., 2008; Nevens et al., 2013). It puts the emphasis on the fact that circular buildings need to be designed according to an integral approach to be successful. Nonetheless, it should be noted that the execution of a circular design is still depended on the assignment, as provided by the client. It is about the translation of the proposed circular solutions into practice.

The execution phase of all the three cases was focused on translating the circular (system) solutions through experimenting with possibilities to add value to their products in the long term. The execution into practice, however, was different in each case. Brummen was focused to execute circular options by contract management. The design team and client gave their approval and permission to execute the proposed circular solution, if it was fulfilling the functional performance needs and ambitions by giving the 'best' value for the right price. Their constraint was their limited budget, but asked for high sustainability standards. They made a list of minimum requirements and conditions that should at least be met without exceeding the limited budget. Alliander made an inventory list of materials from the old building complex and categorised them accordingly to be reused for the new building complex. They also selected the additional building materials according to CE by rethinking the reusability of materials other than it was originally being used. It was about 'just-doing-it' and asked the experts if it was feasible and viable to execute. The execution phase of Venlo followed the principles of Cradle-to-Cradle, but were aware that the development of Cradle-to-Cradle is still immature. For the design team and client this project is also a learning trajectory. Nonetheless, to execute proposed product or material (system) solutions, Cradle-to-Cradle certificate was mandatory and prioritised. The only exceptions were being made if there were no alternative solution available within the given project planning to deliver a fully functional building.

The similarities in the execution phase were to be critical, to challenge experts to be ambitious and to see a building as resource depot to open up new opportunities. For the building as a resource depot, as intended in all the three cases; the actors included it as well in their design and business model, which encouraged long term thinking and future business-proofness. However, the execution of this concept in practice is still an area that needs more research, because it is still unsure how it will develop and if it will guarantee future business-proofness. This was one of the reasons why Brummen did not continue with this concept, because the law and regulations was not ready (yet) to support this. Nonetheless, the other two cases developed different ideas and concepts that correspond with the idea of seeing a building as resource depot for future (economic) value. In which the consortium of the case of Alliander developed a resource building passport; a documented inventory of the products and materials being used, the total amount being used per product or material and where these materials or products can be found in the building. In the case of Venlo Kraaijvanger Architects though about the idea of a resource depot, but were more focused on making producers and suppliers aware to think in future economic values for their products or materials after usage. They advised them to extend their traditional financial bookkeeping with a material bookkeeping to get insight what the potential future economic value could possibly be after its usage. What these concepts and ideas will entail is not visible (yet) and need to be assessed and evaluated in the coming years.

By approaching a circular building assignment more as a process that need to be designed instead of designing a building, experts will continuously be challenged to structural re-evaluate their process. The implication of continuous improvement for business model innovation and living lab in particular is its exploratory nature and the difficulty to capture the acquired (new) knowledge during the process (Almirall and Wareham, 2008). In essence, a circular building process could be seen as developing a new business venture that is exploring possibilities under high uncertainty. To reduce uncertainty a repetitive process of testing solutions, trial-and-error learning, adapting and refining is needed (Blank, 2013; Osterwalder et al., 2014). Therefore, feedback loops and evaluation moments need to be embedded in the process. This can be achieved better when a process is being designed that embrace experimentation and making mistakes to learn and improve what is viable for the given building

context (Blank, 2013; Nevens et al., 2013) then designing a complete building that might look promising. Living Labs as a methodology are in essence a process of fit (Almirall et al., 2012), which is driven by its given (technological/building) context.

The above was very clear in the all the cases, within the monitoring and evaluation phase, in which the feedback, monitoring and evaluation mechanisms are being used to keep challenging themselves to do even better. It is about assessing the products/systems if it complies with the set conditions and are tailor made to fit in the integral design. This also enforce experts to be creative, more flexible and open minded to react and anticipate on real needs of its client (Osterwalder et al., 2014). This means co-designing, testing and repeating is necessary until everyone is satisfied with the end results. It is about aiming for perfection along the process by 'trial-and-error' learning (Marijn Emanuel, 2015; Gert Jan de Gier, 2015; Joan Prummel, 2015). Making mistakes or failures are in fact needed to learn and to improve (Blank, 2013), because these can be analysed very well on things what went wrong compared to very successful projects or what Joan Prummel (2015) stated in the interview (translated from Dutch): *"Success is not only about well executed projects. Failures are also successive if you can learn from it to do it better next time".* As a result, developing circular buildings becomes more a continuous process that need to be maintained and adjusted even after it is delivered. This also include the responsibilities of the producers and suppliers for the demolition at the end of its usage.

The more tangible success cases presented, like Brummen, Alliander and Venlo, will also give a boost for the transition towards a CE. It is important that the lessons learned and end results will be shared. Especially, sharing the results and exchanging knowledge are important stimulators for innovation, like the SPARK Campus Living Lab in Rosmalen. This Living Lab focus on interdisciplinary knowledge exchange or what they called in Dutch 'Kruisbestuiving' shows that it is beneficial to invest in exchanging knowledge (Cassandra Vugts, 2015).

Looking at the overall picture of the comparative inter-case analysis it is clear that ULL aspect are applicable to design a circular building process and successfully facilitate (open) innovation (Schuurman et al., 2015) with all the involved actors. In all the cases the definition of CE was different and also were not well-known about the Living Lab concepts. A well-defined CE definition is necessary to be clear what the CE is and what it is not. This is also applicable for the definition of ULL. By analysing the (pilot) cases of circular building processes the most interesting aspects to include to develop a conceptual facilitation tool are:

- The Envisioning phase should facilitate:
    - The client to formulate their vision and clearly defined ambitions as circular building assignment;
    - The creation of a comfortable but open for competition environment that stimulate integral approaches and multidisciplinary design teams/consortium to work in a co-creative setting;
    - Early involvement of user/client and stakeholders;
    - Process designing instead of a design of a building.
- The Co-creation & Exploration phase should facilitate:
    - Active involvement of user/client and stakeholders;
    - Meetings on a regular base to have an open dialogue between client and stakeholders in order to reveal the real needs and demands in one circular design value proposition.
- The Experimentation phase should facilitate:
    - An iterative process that focuses on co-creative and integral design & build process by regular re-evaluation assessments (co-designing, testing and repeating) of the process;
    - Long term thinking and future business-proofness.

- The Execution phase should facilitate:
    - The translation of circular (system) solutions into practice by ‘just-doing-it’ and contract management;
    - The potential future (economic) value in which a building is seen as a resource depot.
- The Monitoring & Evaluation phase should facilitate:
    - Space to learn, experience and share knowledge;
    - (Re-)evaluate the process regularly and keep asking if it could be done better.

5. The Results of the Design Workshop

The focus of the workshop was based on the process in which awareness can be created with ULL aspects in practice (for programme see Appendix G). In this way fitting solutions can be developed and understanding that the decision-making has their effects on its environment. The approach was divided in two parts (see Appendix H) and presented as a kind of funnel (see section 3.3.3), because by defining the overall vision, the scope and boundaries can be set that emphasised to go more in depth and details by narrowing it down.

The envisioning phase is selected to focus on during the workshop. Within this phase the planning and the design of the process is essential for the realisation. It is the phase where the interaction between and the involvement of multiple actors are high and adjustments can be implemented easier. This also makes it easier to secure the developed guidelines and criteria that are leading.

During the workshop, the overall vision of Circular Building is defined in order to map the needs. With the defined vision, the process of mapping the needs are based on generating the right questions, by involving the right stakeholders in order to get the desired impact. The detailed structure of the workshop and how it is governed is explained in Appendix H. In short, the structure of the workshop was based on the following aspects:

1. Contextual level:
    a. Defining the vision for Circular Building;
    b. Translate the vision into needs and the role of the actors;
    c. Executing the needs to concrete actions plans.
2. Process level:
    a. The effect of asking the right questions;
    b. Finding the right partners to answer the right questions.

The workshop's main purpose is to understand the process in which way the supply and demand between multiple actors can be aligned. Therefore, aspects of CE and ULL will be linked together in a Circular Building Process that can be embedded in a (Circular) Business Model through co-creation and integral design. The findings based on the structure of the workshop will be elaborated on in Section 5.1. The verification of the collected data, by comparing it with the cross-case analysis (Section 4.4), will be elaborated on in Section 5.2, which will create a list of elements for the development of the conceptual facilitation tool.

5.1 The Findings of the Design Workshop

This section will focus on the findings and results of the Design Workshop. The findings are categorised according to the two levels as mentioned in the previous section. During the workshop six participants were present that generated the input on the questions that were asked.

The selection of the participants was based on emphasising multidisciplinary in order to get a well-defined vision for a circular building sector from different perspectives. Within this group of participants three actors of the four categorised actors of the collaborative ecosystem (section 3.1) were present. The only categorised actor that was missing was of the category research.

All the findings of the Design Workshop were collected at the end of workshop and one general summary of the results was being reported and sent to the participants. These results are elaborated in the next paragraphs.

5.1.1 From vision to needs to results

The first round of the workshop was focused on the contextual level. Within this level the participants were asked to define their vision for circular building. To define the vision of all the participants, keywords or short statements were written down on a big sheet (visualisation see Figure 22).

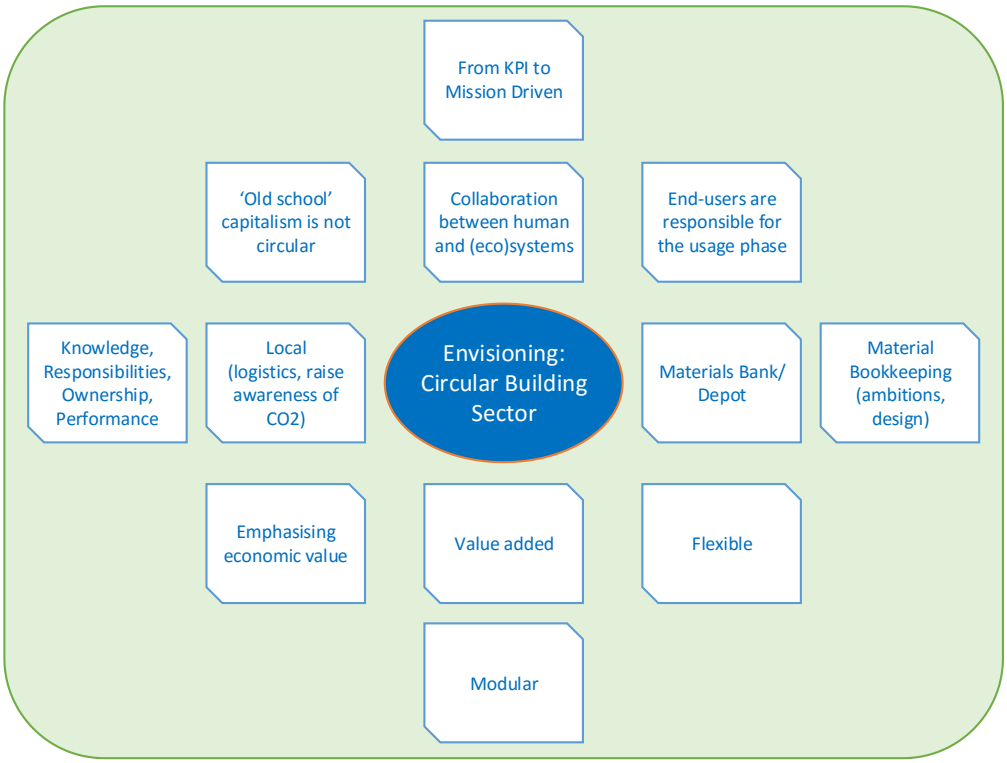


Figure 22: Visualisation of the keywords and statements that are provided by the participants during the workshop that define in their opinions a circular building sector (own creation).

During the discussion about the keywords and statements it became clear that the transition towards a circular building sector should be based on and guided by circular visions and ambitions. To make the move to CE, the clients can provide these circular visions and ambitions as tender assignment on the market. This can be realised if the emphasis will be on the economic value of the products before the construction, during the construction and after the construction. It is also necessary to find the solutions that can be provided locally as much as possible.

Another important element for a circular building sector is that the products and/or services not only add value to the financial aspects, but as well to the technical and social aspects. It is about coupling knowledge with responsibilities, for example, it can be assumed that the producers are the experts of their own products and know how it functions and performs. They are responsible for their products that it performs properly and accordingly when it is being used. The idea of moving the responsibilities to the producers, suppliers and contractors has its effect on the discussion about the rightful ownership of the products or services during the lifecycle, which is determined by performances and results. It is also necessary that constructing a building needs to become flexible and modular, to make it easier to appoint the responsibilities to the rightful owners and make it possible to develop tailor made solutions based on the supply and demand of end-users.

To get a grip on the supply and demand of end-users, the roles of the stakeholders are important as well. It is about the partnership that need to be created between the users and stakeholders in order to understand each other and incorporate circularity. To incorporate circularity that fits the needs, the context of the building needs to be clarified. This is about the facilities that the building provides, the usage of the building by its users and the future perspective of the building. To form the context of the

building, the participants debated about the elements that need to be included. The discussion between the participants developed a list of five elements that should be included to create the building context:

1. Perspective;
2. Uncertainty;
3. Flexibility;
4. Time horizon;
5. Ownership.

For the last two elements, the *Total Cost of Ownership (TCO)* was mentioned as important concept that included both. This was explained during the workshop as a concept in which the buyer and owners financially estimate what their direct and indirect costs are of their products or systems within a certain time horizon (this depends on the type of product or system) and who is responsible for the financial risks. However, some participants did not agree with the concept of TCO, because according to them TCO do not trigger to think more in circularity. It is focused on managing the costs after the product or services are delivered and is about keeping the costs as low as possible, hence, costs oriented. Therefore, they plead for an approach called *Total Value of Usage (TVU)* that is focused on the benefits or the revenues that comes with the mind-set that products and services are 'owned' by the producers or suppliers that need to deliver 'performances' and results for its usage. In this sense it is not about who owns the costs, but it is about how to generate revenue in the course of time.

To put the above in perspective, the pilot case of one of the participants was being used to feed the discussion. The pilot case was *De Koninklijke Bibliotheek* in The Hague and also one of the six selected pilot cases of the *Green Deals Circulaire Gebouwen*. De pilot case of *De Koninklijke Bibliotheek* is selected by the Green Deals, because the corresponding client wants to renovate the building according to the principles of CE in the coming years. It should also be flexible enough to anticipate on future trends and developments of the media (e.g. film DVD's and music CD's) and literature (e.g. books and magazines) market.

During the discussion around the case, it became very clear that specifying the functions of a building is essential to provide fitting solutions. To take the five elements into account, the client should think about the lifespan of the building by questioning if the users will use the building for the same purpose in the coming 50 years or will the media and literature by then be fully digitalised and what type of organisation is needed. To anticipate on these kind of questions, consulting the market can be helpful to explore the possibilities to make the building as flexible as possible to handle the changing dynamics of the market. This also means that (new) business models need to be developed that corresponds with the market, for example, business models that are based on 'sharing business models' or 'adapt to change business models'. The discussion of this case was concluded that time plays an important role in which way buildings would be build and business would be done. Therefore, flexibility need to be imbedded in the process to makes it affordable to adjust the system in order to adapt market changes and to keep fulfilling the functional needs of the users.

In which the case was more specific, the participants were also asked to make a (general) list what the supply and demand are for the users (see Table 18). They were also asked to think about the role that can be taken by the stakeholders with the users and associated contribution to each other for a circular building sector (see Table 19). Based on Table 18 and 19, the next question to the participants was to use their knowledge and practical experiences to formulate general challenges that occur to move towards a circular building sector. The challenges were divided into three general categories: 1) the Companies, 2) the Politics and Government, and 3) the Users.

During this session the participants wrote down the challenges with keywords or statements for each category. For each category five challenges were taken that need to be taken into account and is

considered an important challenge (see Table 20). The five challenges as presented in Table 20 are prioritised but in random order. The extended list can be found in Appendix I.

Table 18: List of the supply and demands/needs of the users to stimulate the transition towards circularity, provided by the participants of the workshop.

	Users
Supplies	- Perspective; - Examples, best practices; - Transparency; - Plan of approach; - Supply/value chain integration; - Performances.
Demands/Needs	- Make clusters to involve neighbouring/local firms to invest in (circular) products and/or services, because together a difference can be made (van Hal and van Bueren, 2012); - Learn from each other and share knowledge (Mulder et al., 2008); - Make clear what the ambitions are and set them as leading criteria for the final design; - Be flexible; - Be aware of the possibilities to solve problems differently.

Table 19: A list of the role of the users/clients and the Stakeholders associated with their contribution to each other for a circular building sector.

	Users/clients	Stakeholders (experts/specialist)
Role	- Be sceptical, keep on questioning; - Find partners to fulfil mutual benefits in the surroundings (e.g. work together with restaurants versus providing your own catering); - Acceptance.	- Make use of the available talents/skills to keep asking (new) questions; - Being equal partners instead of being a contractor (equivalency).
Contribution	- Go into dialogue with the stakeholders; - Involve multiple actors in the design process to define vision and ambitions as design criteria (e.g. the five ambitions of the pilot case of Alliander); - Do market research.	- Go into the dialogue with the users, clients and other relevant stakeholders; - Provide with information; - Develop new ideas for (integral) solutions; - Share knowledge and information with the whole supply/value chain.

Table 20: The five important challenges that needs to be faced by companies, politics and government and society.

Companies	Politics and Government	Users
- Integral thinking and designing; - Total Value Usage instead of Total Cost of Ownership; - Trust and collaborate with each other by sharing knowledge, learning together and creating transparency; - Performance based models instead of price based models; - Accept that you do not know everything.	- Challenge the market for new forms of tendering; - Be open and flexible for change; - Take a more facilitative and supportive role for companies; - More flexible regulations for circular innovations; - Have the courage and take the initiative to be a setting example.	- Get involved as equal partner and as a source to set social objectives or ambitions; - Products as service instead of owning products; - The building should add value for the surrounding environment. - Learn to share or to reuse products; - Tolerance.

Looking at the challenges in Table 20, it is clear that the role of the companies, politics and government and society need to change in order to move towards a circular building sector. The change in role is needed, because intensive collaboration, integral designing and co-creations should be stimulated within a circular building sector. For the circular building process itself, the role of the politics and government need to be supportive. They should facilitate and give space within the laws and regulations to let companies experiment with new technology developments within their R&D department or innovation process. For the role of the society, they should get more involved in circular projects and can be used as a source as well to define local and/or regional social goals and ambitions.

In this part of the Design Workshop, it became clear that it is necessary as a client/user to reveal their vision and ambitions with the stakeholders and its surrounding neighbour. If the building sector want to move towards circularity, the vision and ambition of the client must become the leading criteria for tendering a circular building design. This is another approach than the traditional way of specifying a tender for a building according to the technical details. The adding value for the companies in the market to fulfil the ambitions of a client is the challenge to use their knowledge, creativity and skills at its fullest to come with fitting solutions. This means as well that companies need to collaborate intensively and equally to develop an integral design with the user/client and other actors (even competitors) within the supply/value chain. The process to find the right partners to cooperate can be time consuming, but will be worthwhile if the right consortium is formed.

This multidisciplinary and iterative approach will reveal new possibilities/opportunities by continuously questioning what the user/client really want or need. It will help all the actors to map out the real needs in a shared value proposition. Essentially, to do this successfully according to the participants, next to the intensive collaboration, is to share knowledge and learn from each other. The problem that is being noticed in practice by the participants, is that the learning aspects are not organised properly in the process compared to the organisation to share knowledge in practice. Meetings for sharing knowledge are regularly stimulated and supported by companies and government.

5.1.2 The effect of asking the right questions and the right partners

The process level part of the workshop was focused on sharing knowledge with each other to learn. For this part the two representatives of the pilot case Circular Office Alliander were present. The first thing they wanted to make clear and is essential for the client, if they want to move to circularity in the building sector, is to ask the right open questions to clearly define their ambitions and needs. According to them this challenges the client and experts to go beyond their ‘comfort zone’ and find the partners to collaborate that can fulfil the ambitions. It also increases the chance by stimulating the client and experts to collaborate in a co-creative manner, to come up with ‘smart’ and innovative solutions.

For this process, Alliander reached out for a third independent party to act as a ‘mediator’ (*Copper8*) to support and facilitate them to define their five ambitions for the market. Before the five ambitions were put on the market, it was also essential that the internal organisation agreed with the ambitions and fully supported it. This will not only reduce resistance; it will also create a solid base of support that covers the actions that will be taken. For the Alliander Case, the Board of Management agreed with the ambitions and gave their approval to bring it on the market.

By setting the ambitions on the market as design criteria, it can be interpreted in different ways and from different perspectives. This makes it interesting for the experts to use their own interpretation to realise the ambitions in practice. It also stimulates them to keep asking questions to their client in order to get a clear and total picture what they want to realise. For the client this means as well to be

open minded, transparent and show courage to step out of their own 'comfort zone'. To do this successfully, the group of participants agreed that this can be done by taking a systems approach.

According to the group, a systems approach is necessary because it puts emphasis on the client and stakeholders to include the surrounding environment. This also means involving the neighbours and local firms by approaching them directly for a dialogue or organising meetings to start a dialogue with them. In general terms this mean that the client should start the dialogue with multiple actors (e.g. users, actors in the surrounding environment, private partners, contractors, governmental partners and research institutions).

As a client, involving all the relevant parties in the process to collaborate and give them the opportunities to make circular investments affordable, will create more support for innovations and can convince actors, for example, that the concept of CE can be rewarding. If more circular building projects will follow the path to involve all the parties first before a transaction; this will be made, will affect the way of doing business within this market. By then this means that the market need to be adjusted to make it fitting again for the 'newly' formed way of doing business.

Collaboration with multiple actors can be effective to stimulate innovations if they go into dialogues with each other to understand the different needs and fulfilling them accordingly. These dialogues are considered to be iterative, because you need to go back and forth to make sure that everyone understand each other clearly. The downside of being innovative is taking the responsibilities as either client or expert for the uncertainties and risks that comes with it. Trust by then is an essential aspect to believe as client that the experts will manage the uncertainties and risks and feel responsible to solve problems they encounter. Within the 'traditional' building sector, however, trusting your actors or partners is still an issue. To create trust and believe in your experts that they will solve the (unexpected) problems, is 'practice what you preach' and open communication to create transparency. By doing so, great milestones can be achieved to move towards a circular building sector.

To achieve great milestones, the group is convinced that this can be accomplished by selecting a consortium you want to work with and fit with the defined vision and ambitions. To find the right partners for a consortium is still a difficult task. Good preparation is the base for success for finding the partners to form a consortium. This can either be done with or without a third independent party, but the group suggested that a third independent party can be of great help, due to its independency.

To find out in which way a successful or ideal consortium can be formed, the group was asked to give their opinions (for the results see Table 21) on the next questions:

- What are the conditions that a good client must meet to form a successful consortium?
- How can the (end-)users and stakeholders be stimulated and challenged to make use of their full potential during the whole (circular) building process?
- In which ways can the (end-)users and stakeholders be held responsible for their activities and end results during the whole (circular) building process?

Table 21: The questions and results of the participants by giving their opinion what is needed as a client to form a successful consortium.

Question	Results
What are the conditions that a good client must meet to form a successful consortium?	- Experimentation and learn from the mistakes must be in a way feel like a kind of rewarding. - Be open and share knowledge. - Trust in the agreements that are being made. - Dare to say that you do not know how certain things can be done and ask support of an independent actor as mediator, but remain critical. - Are involved with both the internal stakeholders as the external stakeholders.
How can the (end-)users and stakeholders be stimulated and challenged to make use of their full potential during the whole (circular) building process?	- Keep asking 'Why' questions. - Be courageous to go in dialogue with multiple stakeholders. - Let go of controlling the process by trusting on the knowledge and skills of the experts, stakeholders and/or users. - Challenge each other to adapt the principles of CE and go beyond the 'comfort zone'.
In which ways can the (end-)users and stakeholders be held responsible for their activities and end results during the whole (circular) building process?	- It is about triggering and stimulating the intrinsic motivation of all the actors, because then an actor feels the responsibility to deliver the results. - Let the stakeholders and users sign an open mandate, which describes the role and responsibilities of each actor's tasks. - Gain support of the Board of Management that acts as a solid base and make the client extra motivated to deliver great results.

The ideal consortium according to the participant is about integrity in which the relevant actors can enforce each other to collaborate co-creatively. It helps them as well to ask the right questions as a consortium to formulate the real needs of the client/user and make the actors within the consortium partly responsible for the end results by signing, for example, an open mandate. For the client the challenge is to let go of controlling the process and fully trust on the knowledge and skills of the experts, stakeholders and/or users.

It is important that the client should be aware of its own limitations and must be open minded to face the stakeholders or experts to get support by making decisions. This means be courageous to start the dialogue with the relevant actors, but remain critical by keep on asking 'Why' questions. It will help the client and relevant stakeholders to define a fully understandable shared value design proposition of the needs to work with.

The consortium is in this sense a multidisciplinary network of actors selected by the client in which mutual benefits and (circular) shared values form the key ingredients for collaboration. The role of the client is to find and select 'matching' partners based on their vision and ambitions. Finding the right 'match' determines if the progress of the circular building process runs smoothly and if the final results will turn out to be a (great) success.

To summarise the results of the design workshop, it is clear that if the building sector want to move to a circular building sector, defining the circular vision and ambitions are essential. Therefore, the clients can provide their vision and ambitions as tendering into the market. Before it can be provided into the

market it is recommended to ask for the right open questions to clearly define the ambitions and needs. Asking the right open question is about consulting the market and the users to discover the real needs and be critical by continuously asking 'Why' questions.

If circularity is the main objective, a systems approach is needed in which multiple value is added along the supply/value chain. It is about adding economic, social and technical value before the construction, during the construction and after the construction and as locally as possible with the accompanied actors. This also means in circularity to move the responsibilities to the experts (producers, suppliers, contractors). It is assumed that they are knowledgeable and know best what their products can offer and in which way they can deliver the demanded functional performances by their clients/users.

To get an understanding of the demanded functional performances by their clients/users, collaboration and co-creation between the client/user, surrounding neighbours, local firms and the experts is necessary to create the building context as integral design. The building context is formed by five elements: 1) the perspective of the building, 2) the acceptance of uncertainties, 3) the flexibility of a building's usage and the building process itself for changes, 4) the time horizon and 5) the rightful ownership of products/services. By taking these mentioned elements into account, the actors need to incorporate the lifespan of the building, go into dialogue with all the actors and keep questioning how to anticipate on future trends, what the needs are of their clients/users and if the used business models are still applicable. This can be done successfully with good preparation as a client, to find the right partners to trust and believe in their expertise to form a consortium that can fulfil the client's circular vision and ambition. For the stakeholders next to an intensive collaboration, it is the acceptation to be more open minded to share knowledge and to learn from each other. It is about being courageous to step outside the 'comfort zone' to become more creative in order to co-create new innovations.

5.2 Verifying the Collected Data

The results of the Design Workshop were based on two levels, the circular building content and the process level. Within each level the participants gave their view and opinion in which way the building sector can move towards a circular building sector. In this section these results will be compared with the findings of the cross-case analysis in Section 4.4 to verify both collected data. The verification will be according to the circular building process analytical framework. The focus of the workshop was based on the first two phases: Envisioning Phase and Co-creation and Exploration Phase. The comparison for verification will be therefore based on these two phases (see Table 22). The findings for the Exploration Phase, Execution Phase and Monitoring and Evaluation Phase will be included in the list but cannot be verified through comparison.

Comparing both results, the envisioning phase is emphasising on making the definition of circular visions and ambitions very clear as a client, by collaborating with multiple actors in the field including the neighbours and local firms. This verifies that the involvement of multiple actors is necessary in order to reveal the real needs. Building on these, the building context can be complementary with the vision and ambitions. It supports to structure the process for a circular building. It creates more transparency, because market experts will be consulted to explore the opportunities and possibilities and it helps to formulate the right questions in order to get the right solutions.

Asking the right questions can lead to an open competition in the market to get contracted. The market will become an open competition environment, because contractors are challenged to answer the questions with state-of-the-art or best fitting solutions. This will probably stimulate the stakeholders to collaborate with multiple parties to make an integral design that fit the needs of a client. In other words, it can be described as designing a process instead of a building that match the real needs of a client with the right partners as a consortium.

Table 22: Comparing the findings of the Cross-Case Analysis and the Results of the Design Workshop to develop a list of key elements to be included for the conceptual facilitation tool.

Findings Cross-Case Analysis	Results Design Workshop
Envisioning Phase	
- Clear definition of vision and ambitions by Client; - Open competition environment; - Multidisciplinary and integral design approach; - Process design instead of complete building design.	- Clear definition of circular vision and ambitions are essential; - Market consultations for the possibilities by asking the right question as client; - Pre-phase preparation by defining the building context with all the actors and finding the right partners to form a consortium for the realisation of it.
Co-creation and Exploration Phase	
- Early involvement of stakeholders; - Open dialogues between client and stakeholders.	- Keep asking 'Why' questions; - Co-designing a building; - Systems approach and multiple added values (i.e. economic, social and technical) along the supply/value chain; - Move the responsibilities of the whole lifecycle and performances of the products to the experts (suppliers, producers, contractors).
Experimentation Phase	
- Co-creativity, integral designing and regular re-evaluation assessments; - Long-term thinking and future business-proofness.	-
Execution Phase	
- Translating circular (system) solutions by 'just-doing-it' and contract management; - The potential future (economic) value of building as a resource depot.	-
Monitoring and Evaluation Phase	
- Space to learn, experience and share knowledge; - (Re-)evaluate the process regularly.	-

In both the cross-case analysis and results of the workshop show that a process design, during the co-creation and exploration phase, bring uncertainties when a consortium is working towards a circular building. These uncertainties can be different for each case and is dependent on the building context, the goal of the project and the circumstances. This means that for each case the degree of involvement of a consortium is depended on the way how uncertainties will be managed and will be solved. Nonetheless, as the cases showed and the results of the design workshop suggested is that uncertainties can be managed to go in dialogue with your partners and discus if the proposed solutions are the best options. It is about remaining critical but thoughtful when proposed solutions are presented, by keep on asking 'Why' they proposed a particular solution. This will also move the responsibilities and ownership to the producers and suppliers, because their task in a circular building sector as expert is to provide products that corresponds with the functional performances and needs of the user. This should reduce the uncertainties as well, because if they remain the owner of the products they need to be sure that it last longer and can be used over a longer time span, which means taken into account the products lifecycle.

Another important aspect to keep in mind during the co-creation and experimentation phase is the systems approach and adding multiple value. It prevents that circularity will lose its essence over time during the process. It helps to keep on monitoring and re-evaluating the process as a system to reveal

the challenges or even opportunities as early as possible. This will benefit the flexibility of circular building process to make adjustment if necessary or preferable. Therefore, regular meetings are needed to monitor and evaluate the work in progress and to decide if adjustments are needed for a circular building process.

Given both the findings and results, it validates that innovation and co-creativity through collaboration can be strengthened by defining circular visions and ambitions with all the actors as early as possible. This includes the user/client who need to be actively engaged as a source of knowledge to understand and reveal the real needs. Simultaneously, when the real needs are becoming clear, the market can be consulted to ask and challenge them what the possibilities or opportunities are to realise these. Asking the right questions, be critical, define the building context and select the right partners to form a consortium are essential key ingredients to prepare and design a circular building process based on the client's vision and ambitions.

By asking for a vision and related ambitions, it will trigger the stakeholders to think beyond their 'comfort zone' and accept that great results can be achieved with an integral design, which is designed according to a systems approach. The role of an ULL, then, is to create an open environment in which the essential key ingredients are included to stimulate actors to make well-thought decisions and take multiple perspective into consideration to stimulate collaboration, innovation and co-creation. Therefore, a circular building process becomes an iterative process where asking a process design is more evident than asking for a building design; that will lead to the desired results of a circular building.

With the emphasis on defining circular visions and ambitions that need to be integrated in an iterative circular building process, which stimulates integral designing and co-creation, the list of key elements to be included for the conceptual facilitation tool are:

- Envisioning phase:
    - Define the circular vision and ambitions;
    - Market consultations;
    - Define the building context;
    - Design a process;
    - Open competition environment;
    - Involve all the actors as early as possible;
    - Forming the consortium.
- Co-creation & Exploration phase:
    - Active involvement of key stakeholders;
    - Open dialogues for circular shared value design propositions;
    - Role and responsibilities of the users/clients and experts.
- Experimentation phase:
    - Enhance co-creativity and integral designing
    - Regular re-evaluation assessments (co-designing, testing and repeating);
    - Long term thinking and future business-proofness.
- Execution phase:
    - Translating circular (system) solutions by 'just-doing-it' and contract management;
    - The potential future (economic) value of building as a resource depot.
- Monitoring & Evaluation:
    - Space to learn, experience and share knowledge;
    - (Re-)evaluate the process regularly and keep asking if it could be done better.

6. Conceptual Circular Building Process Facilitation Tool

Building on the results of the case analysis (Chapter 4), the design workshop (Chapter 5) and literature review (Chapter 2) to enhance circular building in the building sector, this chapter will propose a practical Circular Building Process Facilitation Tool that incorporates elements of ULL. This is assumed as an ideal circular building process that is derived from the cases and supported by the results.

6.1 Building Blocks for Facilitation Tool

The purpose of the tool is linking ULL element with the CE principles. It embeds both strengths of the concepts where the CE principles are leading to build a circular building that is designed according to the ULL method, hence, an integral, user-centric, trial-and-error learning, co-creative and collaborative ecosystem approach. By bringing these two concepts together, the Circular Building Process Facilitation Tool will be developed as an improvement of the traditional building process trajectory (Arditi and Gunaydin, 1997).

The facilitation tool adapted the conceptual model 'Smart City as Collaborative Ecosystem' of Baccarne et al. (2014) to develop the conceptual model 'Circular Building Process as Collaborative Ecosystem' (Section 3.2.1). The main idea of this conceptual model is to understand the interactions and what the affordance flows are on the systems level between multiple actors. It also makes clear what types of actors should be involved in the Circular Building Process.

To map the types of actors needed to be involved in the Circular Building Process, it is necessary to govern the process properly, taking into account time, space and willingness to learn, experiment and operate within an open and comfortable setting. The UTL of Nevens et al. (2013) is a platform that is grounded on the idea that openness for different approaches and co-creation will lead to innovation. These reinforcing elements can vary from long-term foresight up to on-the-field experimenting (Nevens et al., 2013). By adapting these elements of UTL a clear structure of the Circular Building Process is developed (Section 3.2.2) that support the framing of case analyses and can be used as well as guidance for new circular building projects.

The Circular Building Process Facilitation Tool is the process that connects both concepts in order to find the right partners as clients to collaborate within a multidisciplinary consortium/design team (i.e. architect, real estate developer, builder, installer/engineer, interior designer and urban planner), explore new opportunities in CE through experimenting and learning from it. It is doing business by refining and executing the circular solutions until satisfied by all the key actors (Blank, 2013; Osterwalder et al., 2014) and considering the circular building as a resource depot (Schouten, 2014). This Practical Facilitation Tool should guide them through these processes to make the right decisions and encouraging them not to be afraid to make mistakes.

To bring the concepts and the elements together, Table 23 provides an overview of all the Circular Building Process elements of the suggested phases that should be included in the facilitation tool. These elements are the building blocks that contain characteristics for the circular building process, which can be initiated by key facilitation aspects to guide both the client and consortium along the process.

Table 23: Building blocks for the Circular Building Process Facilitation Tool.

Circular Building Process Analytical Elements	Characteristics	Facilitation Key Aspects
Circular Building Process as Collaborative Ecosystem		
Full Ecosystem approach	- Mapping the key actors; - Output of one system provides input for another system and vice versa; - Generation of values.	- Connecting multidisciplinary actors in a Circular Building Network; - Interaction between actors.
Envisioning Phase		
Circularity	- Definition of Circular Economy; - The two general themes for circular building; 1) new build and 2) renovation/retrofitting.	- Define the circular vision and ambitions; - Define the building context.
Future Vision	- Defining Vision & Ambitions	- Market consultations;
Setting the Stage	- (Flexible) Process design; - System analysis; - Preparation and organisation of the assignment.	- Open competition environment; - Design a process.
Circular Shared Value	- Selection Procedure; - An adaptable plan of action.	- Involve all the actors as early as possible; - Forming the consortium.
Co-creation & Exploration Phase		
Degree of Actor Involvement	- Participatory Process; - Actor involvement; - Circular Product Design Strategies.	- Active involvement of key stakeholders; - Open dialogues/meetings for circular shared value design propositions.
Collaboration Approach	- Coordination Approach; - Participation Approach; - Innovation-mechanism.	- Role and responsibilities of the users/clients and experts.
Experimentation Phase		
Discovery	- Translating future vision and ambitions into feasible and viable action agendas; - Circular product design; - Time and money constraints; - Uncertainties and risks.	- Enhance co-creativity and integral designing; - Regular re-evaluation assessments (co-designing, testing and repeating).
Business Development	- Value proposition designs; - Circular business model design strategies.	- Long term thinking and future business-proofness.
Execution Phase		
Translation of Solutions	- Minimum viable proposition of a circular solution.	- Translating circular (system) solutions by 'just-doing-it' and contract management.
Building as Resource Depot	- Preservation of resources.	- The potential future (economic) value of building as a resource depot.
Monitoring & Evaluation		
Learning	- Trial-and-Error; - State-of-the-art solutions.	- (Re-)evaluate the process regularly and self-assessment.
Sharing Experience	- Best Practices; - Knowledge; - Changing mind-sets.	- Space to learn, experience and share knowledge.

6.2 Developing the Circular Building Process Facilitation Tool

The aim of the Conceptual Circular Building Process Facilitation Tool is to emphasise co-creation, collaboration and experimentation within a circular building network and make it practical to execute. Therefore, approaching it as 'designing a process' instead of presenting a designed circular building is a good methodology to make people acquainted about the benefits and the adding value of a circular building. That a circular building process can generate profitable and tangible results by keeping

experimenting with the uncertainties and reduce them along the process. As Nevens et al. (2013: 199) states, real life 'transition experiments' are the ones that generate tangible results along a transition trajectory and are considered to be genuine. The downside of these 'experiments' is that they carry a degree of possible failure and risks for the actors involved. For this particular reason the Circular Building Process Facilitation Tool allows actors to fail when experimenting new solutions that fit the given context (i.e. vision and ambitions) of the client, as longs as they can learn from potential failures. This is seen as a 'test-validate-learn' cycle that is adapted from the 'build-measure-learn' (Ries, 2011) (see Figure 23). Testing is the circular solution hypothesis that have the intention to learn from it. The next step is to validate the solution if it is in line the user/client's desired needs. This will generate feedback that can be learned from and to make refinements accordingly. If you cannot explain or learn from their failures, then the 'experiment' is considered a failure (Nevens et al., 2013). This suggests that the process model of the Circular Building Process can be seen as a learning process as visualised in Figure 24.

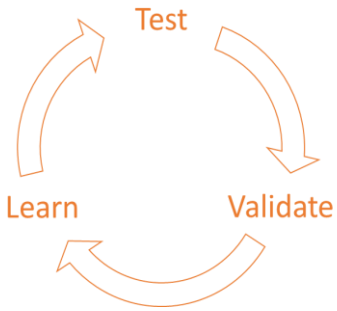


Figure 23: Test-validate-learn cycle adapted from Ries (2011)

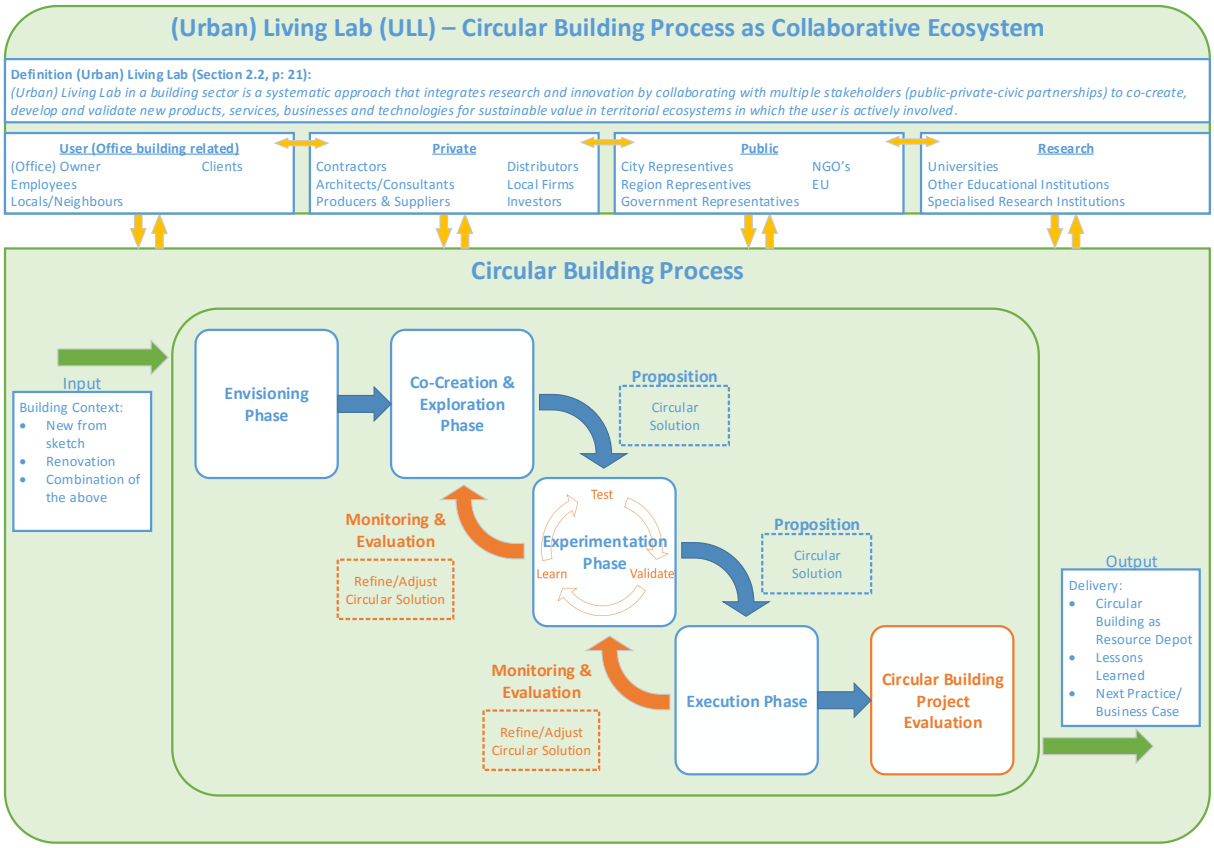


Figure 24: The Conceptual Model of the Circular Building Process as Collaborative Ecosystem that embedded the ULL elements. This model is taken from the models of Baccarne et al. (2014), Nevens et al. (2013) and Blank (2013). Yellow arrows: Collaborative interactions, Green arrows: Input and Output flows, Orange arrows: feedback loops and Blue arrows: Decision-making.

6.2.1 Getting started: The Circular Building Process

As shown in Figure 24, the Circular Building Process as a collaborative ecosystem distinguishes four types of actors in a network that should be involved; User, Private, Public and Research. Within this network all four types of actors should be involved to collaborate in the ULL (Baccarne et al., 2014; Juujärvi and Pesso, 2013; Romero and Flores, 2009). These interactions between actors in this collaborative ecosystem is assumed to be open and transparent. As in every project it starts with an initiator that provides input to a system or process. In a circular building process, the client is the initiator that determines the building context or type of circular building project. Obviously, the output of the circular building process will be a functional circular building and knowledge that can be shared and can be learned from. The whole trajectory from input to output is seen as an iterative process that emphasises integral designing, co-creation and experimentations. Experimentation in this process means trial-and-error, failures are allowed as long as you are able to improve using lessons learned. This means proposing circular solutions for execution need to be tested, discussed and validated by getting feedback from either the client or consortium or both. This repetitive cycle will support stakeholders to refine and adjust their circular solutions accordingly. However, this process should not take endlessly, so decisions need to be made in line with the given time and budget. To oversee this process a third external party can be supportive by facilitating the circular building process, so the client can focus on their 'real' needs and ambitions, and can also support the client to make overarching decisions.

Fulfilling those real needs multiple stakeholders should co-create to generate a circular integral design by exploring the possibilities within the given circular building context. The intention is to create a setting for all the actors that favours a situation that benefits all of them. To create such a situation, an iterative process is needed where experimentations connect multiple needs together (Osterwalder et al., 2014). These experimentations should result in one circular system design that everyone agrees with. The execution is the next phase to realise the circular building system design. During this phase it is still possible that barriers may occur that were not discovered during the experimentations. If it causes significant problems for the whole design, then it should be resolved by refining or adjusting the system design. If the problems are not affecting or slightly affecting the end results of the circular building, then consider if you want to do something about it or not. Whatever the decision, it should be evaluated at the end of the circular building evaluation.

6.2.2 Practical Facilitation Tool as Guidance Towards Circular Buildings

The Circular Building Process (Figure 24) starts from the abstract/system level (i.e. collaborative ecosystem), followed by creating a circular design (i.e. facilitating and governing the process) until it is being used by its client (i.e. execution and evaluation). This is translated, developed and embedded in a practical facilitation tool that is based on a decision-making process flow diagram with only 'Yes' or 'No' questions asked. By including only 'Yes' and 'No' questions for guidance makes it a linear/sequential process. It will help the client and consortium through the steps in the process to make CE related decisions and recommendations. The formulation of these questions and where it is based on can be found in Appendix J.

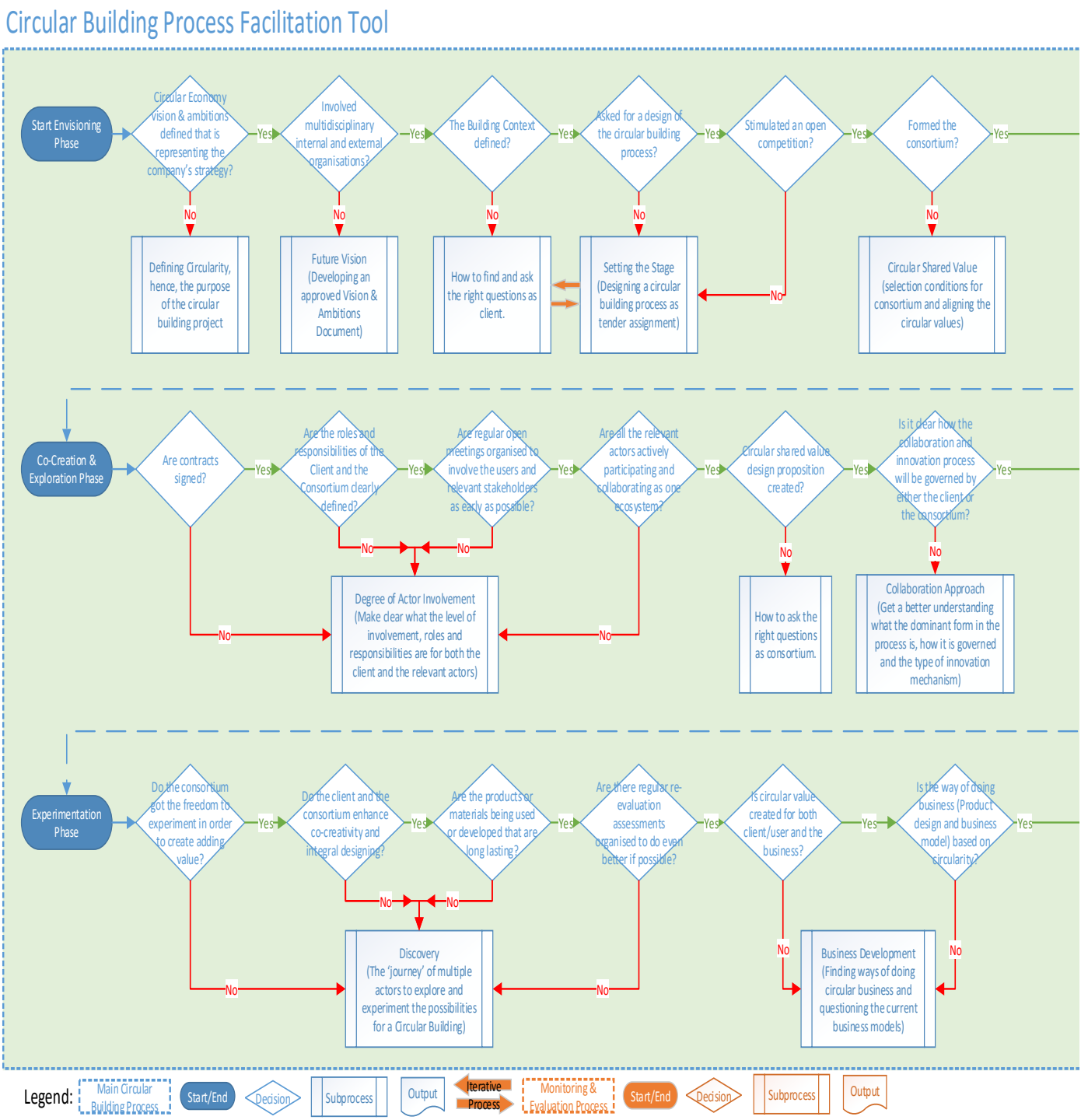
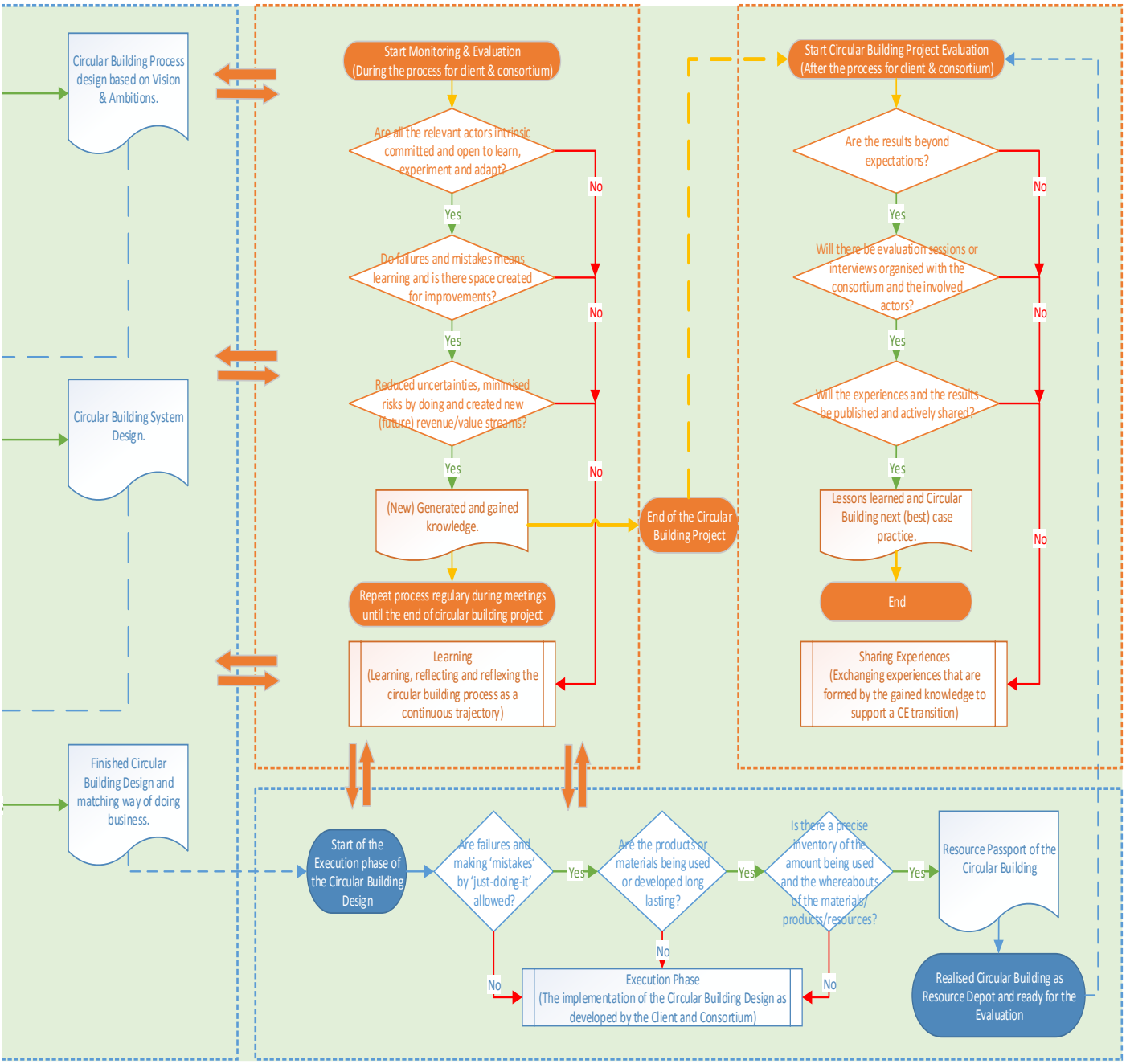


Figure 25: Summarised Conceptual Circular Building Facilitation Tool, the detailed process of each phase can be found in Appendix K. Within each phase advised action points (also includes and applied ULL elements) are formulated to guide both the Client and the Consortium to think in terms of circularity (own creation).


Circular Building Process design based on Vision & Ambitions.
Circular Building System Design.
Finished Circular Building Design and matching way of doing business.
Start Monitoring & Evaluation (During the process for client & consortium)
Are all the relevant actors intrinsic committed and open to learn, experiment and adapt?
Yes
No
Do failures and mistakes means learning and is there space created for improvements?
Yes
No
Reduced uncertainties, minimised risks by doing and created new (future) revenue/value streams?
Yes
No
(New) Generated and gained knowledge.
Repeat process regulary during meetings until the end of circular building project
Learning (Learning, reflecting and reflexing the circular building process as a continuous trajectory)
End of the Circular Building Project
Start Circular Building Project Evaluation (After the process for client & consortium)
Are the results beyond expectations?
Yes
No
Will there be evaluation sessions or interviews organised with the consortium and the involved actors?
Yes
No
Will the experiences and the results be published and actively shared?
Yes
No
Lessons learned and Circular Building next (best) case practice.
End
Sharing Experiences (Exchanging experiences that are formed by the gained knowledge to support a CE transition)
Start of the Execution phase of the Circular Building Design
Are failures and making 'mistakes' by 'just-doing-it' allowed?
Yes
No
Are the products or materials being used or developed long lasting?
Yes
No
Is there a precise inventory of the amount being used and the whereabouts of the materials/ products/resources?
Yes
No
Execution Phase (The implementation of the Circular Building Design as developed by the Client and Consortium)
Resource Passport of the Circular Building
Realised Circular Building as Resource Depot and ready for the Evaluation

The translation from the Circular Building Process into a practical facilitation tool is summarised in a process flow diagram as shown in Figure 25. The purpose of the summarised visualisation is to provide practitioners a quick guidance of the steps to initiate circular building projects. The elaborated processes for these guided steps to initiate circular building projects can be found in Appendix K. Within the elaborated process not only the steps of each phase are translated into questions, it also provides action points for both the client and the consortium in what way they could improve or should discuss what circularity is and means for them. As it becomes clear in all the three cases, the key ingredients for a circular building are clearly defined circular vision and ambitions that also gives the freedom for interpretation. It is the circular vision and the commitment to follow it that determines the circular building process its success. This is in line with the findings of Nidumolu et al. (2009), Nevens et al. (2013) and Bocken et al. (2015). They all agree that if 'circularity' and the vision are aligned it will stimulate new ways of thinking, collaboration forms and innovations.

Envisioning Phase

To stimulate new ways of thinking, collaboration forms and innovation starts with the envisioning. The envisioning phase facilitates the client to:

- Define the circular building context;
- Define the future circular vision and ambitions;
- Refine or adjust the circular future vision and ambitions through market consultations;
- Setting the stage by stimulating openness and transparency in an open competitive environment;
- Ask for a design process instead of a complete building design;
- Involve all the actors as early as possible;
- Form the multidisciplinary consortium based on synergy and circular shared value.

That the future circular vision and ambitions should be considered as the basis for tendering was visible in the case of Alliander and Venlo. Both cases made it possible to ask for a process design that was flexible and gave them the freedom for interpretation, which resulted in circular shared value. It is the process to start from a vision to a circular shared value that add value for developing circular buildings. This envisioning process takes time to get well defined vision and ambitions to make it fitting for the circular building context and create circular shared value by involving all the actors as early as possible (Appendix K-1). It is an intensive process with lots of interactions with all the actors involved, market consultations and organising open dialogues. This is for most of the clients a challenging process, because they need to step out of their 'comfort zone', be open and also become vulnerable. To succeed with such a process, it is necessary to trust the experts that they will propose fitting solutions.

For the client to step out of the 'comfort zone', become vulnerable and gain trust in the experts that they are skilled and knowledgeable enough, and committed is about asking them the right questions, as several interviews mentioned. The problem that client encounter is that they do not know where to start and what the right questions are to ask. Therefore, the supportive process flow diagram for the envisioning phase, as visualised in Figure 26, is developed to facilitate them. This flow diagram shown in Figure 26 aims to help the client to find the right questions to ask in order to stimulate circularity and creating a setting where experts are challenged to use their knowledge to give the right answers. It helps the client to clarify their ambitions together with the experts and can be used as well to find out the potential partners to collaborate with. Additionally, it can be seen as an assessment for the client as well if they are still asking for a circular building process design and not tend to a pre-designed circular building.

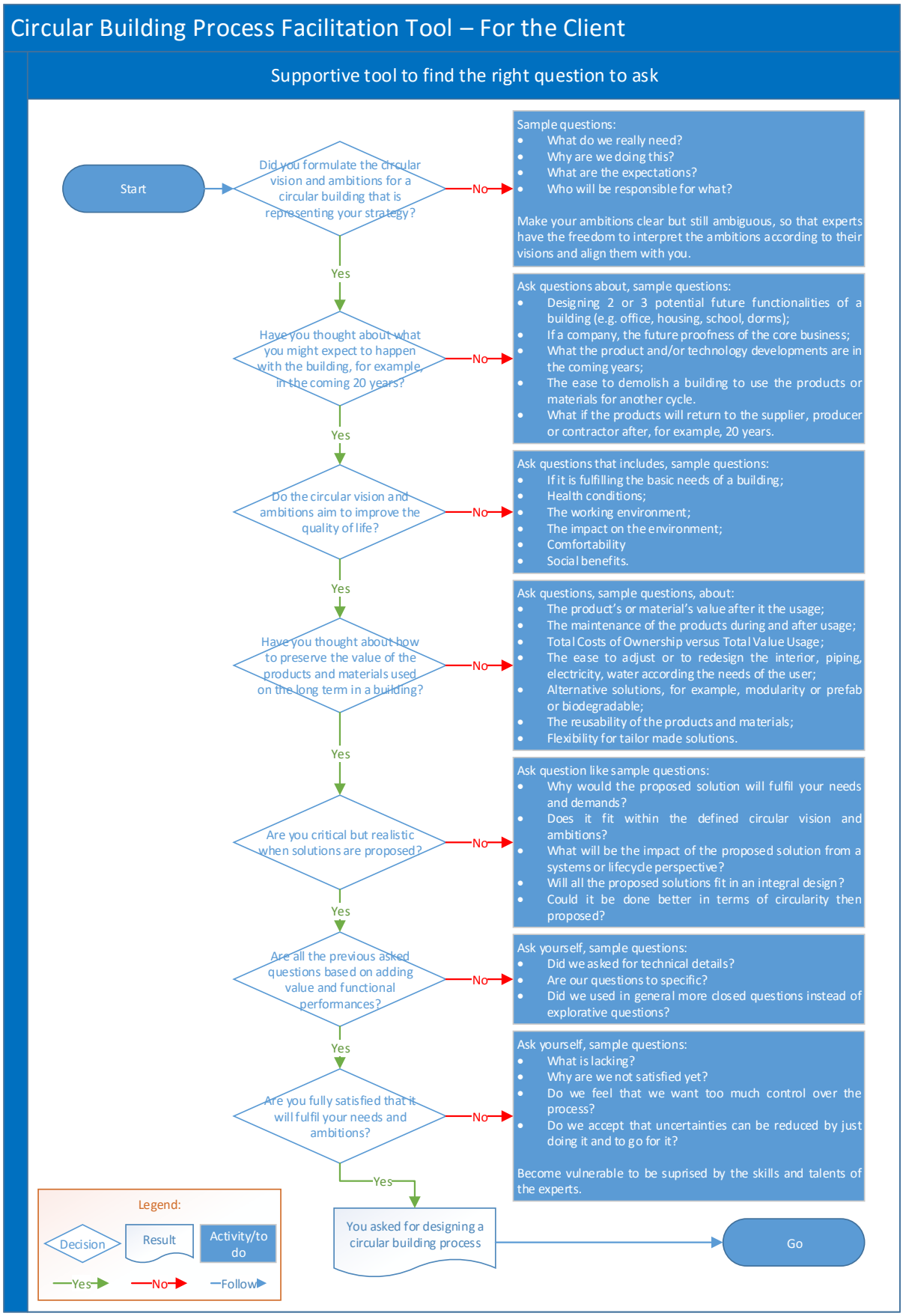


Figure 26: Supportive tool for the Client to find and ask the right question for the Circular Building Process (own creation).

Co-Creation & Exploration Phase

If a consortium is being formed and the client's vision and ambitions are defined for the circular building process, the next step is the governance of the process and explore the possibilities. The co-creation & exploration phase aims to facilitate both the client and consortium to:

- Involve the key stakeholders actively;
- Organise regular open meetings with stakeholders to develop circular shared value design propositions;
- Make clear what the role and responsibilities are of the user/client, consortium and stakeholders.

According to the case analysis and interviews, active involvement of stakeholders for co-creation to develop shared value design propositions is one of the key aspects for a successive Circular Building Process. Coordinating the collaboration to explore circular design strategies to develop circular shared value design propositions, it is important to understand what the participative role of all the actors will be at early stages of the project and along the whole project trajectory (see Appendix K-2). This can be done hierarchical by centralised or decentralised coordination or by considering everyone as equal partners where no clear hierarchy is visible as long it is elaborated in a contract and signed by the client and consortium. In what way the Circular Building Process is coordinated, the involvement of stakeholders actively is still preferable.

The type of coordination and participation approach is decisive for the project trajectory in what way innovation for circular design strategies will be structured and governed. For example, Venlo was in general hierarchical centralised coordinated by strictly focus on Cradle-to-Cradle solutions and stakeholders should comply with these conditions. Therefore, certifying the products and materials according to the standards of Cradle-to-Cradle principles were leading and driving force for innovation. This is what the stakeholders have done by exploring their own possibilities to get certified. In contrast, the case Brummen was hierarchical decentralised coordinated and gave the stakeholders the freedom to come with innovative solutions that would serve their functional performance needs and ambitions. In the case of Alliander, all the stakeholders and users were seen as equal partners to use all their knowledge combined in order to come with innovative solutions; in line with the ambitions of Alliander.

An important activity, is to organise 'open' meetings with all the stakeholders together regularly. The emphasis on open meetings is to stimulate transparency and to use all the knowledge that is available to solve problems. These meetings are not only for planning and evaluating the process, but to stimulate collaboration as well to help each other with their problems and to solve it. Therefore, this activity is embedded in the co-creation and exploration phase and is one of the tasks for the consortium to do.

How the consortium can facilitate the task to support and help the stakeholders and client/user with aligning their different needs is to ask them as well the right questions. The supportive process flow diagram, as shown in Figure 27, support the consortium to facilitate them to asking the right questions to trigger circular systems innovations and taking the needs of multiple stakeholders into account. This can be effective and helpful to find flaws in designs during the exploration phase as is seen in some examples of the three cases analysed; the functional 'floating and wavy' energy-rooftop of Alliander, the organised 'Atelierdagen' by Kraaijvanger Architects for Venlo and the over dimensioned wooden construction in the case of Brummen.

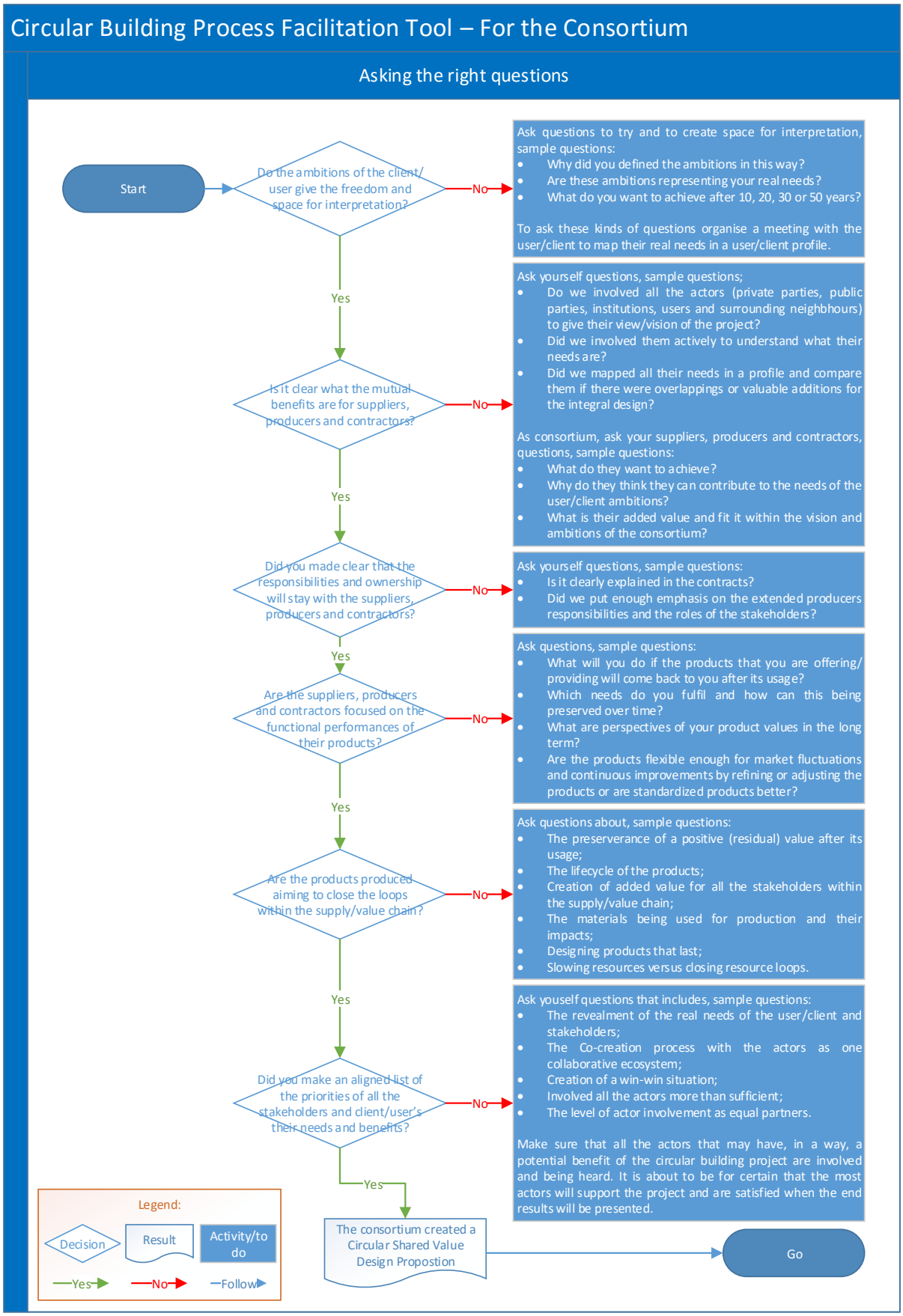


Figure 27: Supportive tool for the Consortium (i.e. architect, real estate developer, builder, installer/engineer, interior designer and urban planner) to ask the right question within the Circular Building Process (own creation).

Experimentation Phase
When the possibilities are explored and the structure of the governance is in place, the next phase is to validate the possibilities. The experimentation phase is focused on repetitive cycles of testing and validating the circular building systems design and to learn if it is feasible and viable or not. Therefore, this phase is focused on facilitating both the client and consortium in order to:

- Enhance co-creativity and integral designing;
- Organise regular re-evaluation assessments to challenge stakeholders to be ambitious and to learn by using a trial-and-error approach;
- Think about future impacts of the products and materials that are going to be used and what long-term thinking will mean for the future business-proofness.

What the experimentation phase in the practical tool entails is the management of uncertainties. Managing uncertainties is about experimenting with new or alternative solutions and make it tangible though testing and validating potential solutions to execute as a business. In other words, this means that the experimentation phase of the Circular Building Process Facilitation Tool is focused on making the proposed solutions feasible and viable (see Appendix K-3). The questions in this phase are, therefore, formulated in such a way to manage uncertainties and find the possibilities for circular designs and capturing the circular values within a business model that fit within the given building context (Bocken et al., 2015).

Execution Phase
As the experimentation phase is focused on managing uncertainties, which results in proposing circular solutions that can be applied for businesses, the execution phase is focused on translating these circular solutions into practice. Therefore, this phase facilitates mainly the consortium and involves stakeholders (e.g. contractors, producers, suppliers) to:

- Make the translation of the circular (system) solution by applying them into practice, which is in line with the signed contracts;
- Think about the potential future (economic) value if a building is becoming a resource depot.

The execution of these potential solutions is about the future proofness of doing business and the building itself. As discussed in the circular business model innovation literature (Section 2.3) and the development of the analytical framework (Section 3.2), the execution phase is added and translated according to the lean start-up methodology. For the Practical Facilitation Tool this phase is built on the findings of the cross-case analysis (Section 4.2). The analysis reveals that all the three CE oriented buildings are constructed with in mind that the materials/products/resources can be (re)used for multiple lifecycles (see Appendix K-4). This changes the way of doing business and initiates the idea that buildings are being seen as resource depots. From this perspective, the purpose of using the resources and materials in constructing a circular building changes as well. This also effects the role and responsibilities of the client, the consortium and the contractors (e.g. producers and suppliers).

By doing so, it becomes more important to make an inventory of the amount of materials/resources/products that are being used in a circular building and where these can be found when, for example, a building will be renovated or demolished. Therefore, the case of Venlo discussed to add the future value of materials through bookkeep next to the traditional finance bookkeeping. Alliander developed an elaborated resources passport of their circular building that creates transparency. Both ideas or concept can initiate new business models that incorporate materials bookkeeping and resource passports. With this in mind the Facilitation Tool considers the execution phase as the process of constructing the co-designed circular building by executing the viable circular or system solutions in a functional building as resource depot. It should trigger multiple stakeholders to listen to their customers what their real needs are, design products that are lasting and incorporate it in a circular business models. This should be achieved by relating it back to the other phase of the Circular Building Process to monitor and evaluate the results. This is important by means of keeping

the alignment with the visions and ambitions of the client/user. These monitoring and evaluation sessions should be used to get feedback to refine or adjust the proposed circular solutions from the client and monitor the process by (re-)assessments and/or (re-)evaluation.

Monitoring and Evaluation
As stated the Circular Building Process can be seen as a learning trajectory for constructing circular buildings. For this particular reason it is important that the process itself is continuously monitored and evaluated. Therefore, the Monitoring and Evaluation part is not seen as a separate phase, but a continuous process that keeps track on the activities done during the process. It is a mechanism that facilitates both the client and consortium to:

- (Re-)evaluate the process regularly and let the client and consortium constantly asking themselves and each other if it could be done better;
- Create space or an environment where making mistakes or failures are allowed that is seen as experiences to learn from and to share the knowledge available for everyone that is interested.

This continuous process is in line with the trial-and-error aspects in which the tool stimulates the client and consortium to organise on regular base monitoring and evaluation sessions along the process. All the questions that are formulated within this process are aimed to support the client and the consortium to develop circular buildings that can be used, but as well to learn from it by giving and receiving feedback (Appendix K-5). This part of the Practical Facilitation Tool stimulates the learning experiences during the process by regular monitoring, (re-)assessing and (re-)evaluating the work in progress. It is enhancing the commitment within the group to do it even better during the process.

After the execution phase the circular building is completed for delivery. Before the circular building process comes to an end, the last step of the tool is to facilitates the evaluation of whole trajectory in order to create a business case where others can learn from. This is about presenting a business case and lessons learned that can be shared with others to learn and adapt. For the client and consortium these evaluations help them to do it better or differently in their next circular building project.

6.3 Added Value of the Circular Building Process Facilitation Tool

The circular building process combines the principles of CE with aspects of ULL and UTL. Based on these concepts a practical facilitation tool is being developed. This tool emphasises collaborative co-creation by seeing the Circular Building Process as a learning process through experimentations, which is initiated by asking vision and ambitions as leading conditions. The emphasis of experimentation is based by both the ULL and UTL concepts. ULL sees a building network as collaborative ecosystem and UTL focuses on the governance of open innovation platforms.

The facilitation tool includes experimentations but also goes a step further by focusing on executing these experiments as well into viable solutions and businesses. This result in a fully functional circular building, which should be seen according to the principles of CE as a resource depot. To do this successfully, the case analysis and interviews give insight for a successive Circular Building Process. Its success is related by the degree of actor involvement, transparency, the trial-and-error approach and the interactions between the actors in the early stages of the project and along the project trajectory. Therefore, the role of activity of the client and the consortium is more dynamic and is dependent on the phase of the project and the circumstances at that moment. For these reasons the process is naturally iterative. This is what the Circular Building Process Facilitation Tool wants to emphasise in general. It is about building a relationship with the actors that is based on trust and mutual benefits along the process, which in the end of the process should result into a fully functional circular building; in line with the vision and ambitions. It is about designing a process instead of pre-designing a complete circular building, which is otherwise conflicting with the flexibility and adaptability of constructing a circular building.

The Circular Building Process Facilitation Tool is focused on improving the current building process by developing a process flow diagram that guides the practitioners along the process and emphases value creation through co-creation. It should help them to understand what CE means in general as well as for the building sector, what the right questions are to ask the experts as client and what the right questions are to ask the stakeholders as consortium to align different needs.

As mentioned earlier, constructing a circular building is a learning process where uncertainties can be managed and reduced by constant experimenting with potential circular solutions and allow making mistakes or failures as long it can be learned from. This is a repetitive cycle of testing, discussing validating until all the involved actors are satisfied with the (end) results.

To facilitate practitioners through all the phases as discussed, the elaborated processes as developed for this research do not only provide questions that guide them and to make value based decisions, but also action points as recommendations what they can do. It is about creating awareness and making thoughtful decisions along the whole circular building trajectory.

After the delivery of the circular building the tool also embeds the need to evaluate the whole trajectory to create a business case where others can learn from. This will help the transition towards CE to go quicker, because tangible results and setting examples can be produced. By sharing the results, more knowledge can be generated that is beneficial for everyone interested. However, the questions are if the facilitation tool will produce the intended results, hence, circular buildings, triggers co-creation between multiple actors and helps to create new partnerships or collaborations to initiate new circular building projects are still unclear. This could not be tested and validated, because the aim of this thesis, due to time constraints, was to develop and propose a conceptual tool. Therefore, the tool aims to facilitate both the client and the consortium through a Circular Building Process to design and construct a Circular Building seen as a resource depot and to explore ways of doing business to achieve this successfully.

7. Conclusion and Discussion

7.1 Conclusion

The built environment in general is a dynamical system that is dependent on the available materials and resources. Especially, for the Dutch building sector this is quite a challenge, because most of the time they are dependent on these materials by importing them. Therefore, the concept of CE provides new possibilities to be innovative and less dependent on the import of building materials. To think in new possibilities in the building sector, three cases were analysed in this thesis. The cases revealed that asking the questions differently during tendering in the form of a vision and ambitions, as leading criteria for a circular building, to the market can lead to outstanding results. It is not about asking for technical details but for functional performance needs.

The three cases have showed that embracing the principles of CE, by focusing on the preservation of resources while reducing the amount of waste in line with material efficiency, can be beneficial in the current economic system: a 'linear' buy-and-consume market. In the first case Town Hall Brummen asked for functional performances instead of specific details how the building should look like. It showed that the financial crisis in the 2008 was not seen as a barrier but as a challenge to realise a sustainable building with a limited budget. By asking for functional performances the ambitions of the Municipality of Brummen was leading for the end results. This included that the experts became the owners of the products, which makes them directly responsible to provide the functional needs as stated in the ambitions of Brummen.

In the second case Circular Office Alliander was innovative in their tendering by providing the market with a vision and five defined ambitions that need to be fulfilled. For this particular case they truly put emphasis on circularity, integral designing and co-creation. To be sure that these elements were leading, Alliander asked Copper8 to facilitate them independently through the tendering process and to help with the selection of a multidisciplinary consortium to execute the project. What became clear in this case was the fact that they did not asked for a complete design of a circular building but they asked for process design that would lead to a circular building. By doing so, developing a circular building was more a way of managing uncertainties. To reduce uncertainties, it was important that the right questions were asked by the client and the consortium.

The third case Cradle-to-Cradle City Hall of Venlo was, like the second case, innovative by providing only a Cradle-to-Cradle ambitions facilitated by C2C ExpoLAB to the market and asked architects to give their vision that will match these ambitions. The awarded architect, Kraaijvanger Architects, also decided to propose a process design instead of a complete Cradle-to-Cradle designed building. The reason was that it gave them the freedom for interpretation and to cooperate with partners to be sure that the real needs of the clients would be fulfilled.

Beside the innovativeness of using a visions and ambitions for tendering, another interesting development occurred alongside, which was asking for a building process design instead of a complete building design. This provided the relevant actors in the cases of Alliander and Venlo more flexibility and adaptability along the Circular Building Process to propose circular/systems solutions. For Town Hall Brummen, they did not ask for a building process design, but asked for a semi-permanent building design that would last for at least twenty years. Together with RAU Architects and Royal BAM, the building was designed in a way that it would emphasised the functional performance needs. For the experts, the flexibility and adaptability was focused on designing products or services that could be taken back after its usage.

These three cases have raised the bar for future building projects by changing their mind-set and applying CE principles. In which vision, ambitions and functional performances as criteria are leading for the building process. This was also helpful to select the right partners to form a cohesive and multidisciplinary consortium to stimulate creativeness. It triggered to go beyond the 'comfort zone' and became successful by integral designing and co-creating along the circular building process. This also changed the way of collaboration between the client/user, which was more iterative by nature. It was iterative, because the client and experts were continuously challenging each other to do better or more circular by structural re-evaluating the process. Therefore, the concept of ULL was helpful to understand what was needed to create an open innovation environment (Schuurman et al., 2015). It also included the essential key ingredients to stimulate actors to make well-thought decisions and to take multiple perspectives into consideration, which stimulated collaboration, innovation and co-creation.

The comparison of these three cases according to the developed analytical framework for a Circular Building Process as Collaborative Ecosystem (as discussed in Section 3.2) to analyse the involvement of actors and the interaction between multiple actors, provided some interesting patterns, which are:

- Defining (circular) vision and ambitions to put on the market;
- Asking for a process design instead of a complete design of a building;
- Functional performances/adding value orientated instead of price orientated;
- Pre-selected a cohesive multidisciplinary design team/consortium;
- Changing responsibilities, experts become responsible for the functional performances that need to be delivered and the client must let go of controlling the process by becoming more vulnerable;
- Early involvement of users and stakeholders within the process;
- Thinking in creating and preserving future value of products:
- Creating space to learn (making mistakes are allowed as long you can learn from it) and share knowledge.

Given the case findings and the results of the analytical framework, a design workshop was organised. This workshop focused on the envisioning of a circular building sector in general and on the design phase of a circular building process in order to validate the findings. During the workshop, it was clear that if the building sector wanted to become more circular, defining a circular vision and related ambitions are essential. It was necessary as client to ask the right open questions and to consult the market to discover the 'real' needs and to be critical but thoughtful by continuously asking 'Why' questions. If circularity was the main objective for circular buildings, a systems approach was needed that add multiple values (economic, social and technical) along the supply/value chain and the entire building process trajectory and after its usage. This means that the responsibilities would move to the experts (producers, suppliers, contractors), because during the workshop the participants agreed that the experts were the ones that were knowledgeable and knew best what they could offer and deliver. Therefore, a well-defined building context is needed to initiate the building process. A well-defined building context, according to the participants of the workshop, should contain the following five elements: 1) the perspective of the building, 2) the acceptance of uncertainties, 3) the flexibility of a building's usage and the building process itself for changes, 4) the time horizon and 5) the rightful ownership of products/services. This means that a building context need to incorporate the lifespan of the building, to go into dialogue with all the actors and keep questioning how to anticipate on future trends, what the needs are of the clients/users and if the used business models are still applicable.

As the workshop concluded, to make the building sector more circular, the essential key ingredients to prepare and design a circular building process as client were: 1) ask the right questions, 2) be critical but thoughtful, 4) define the building context and 5) select the right partners to form a consortium.

To incorporate the findings, the conceptual model of the Circular Building Process as Collaborative Ecosystem is being developed (Section 6.2, Figure 24). This model suggests that the developing and

constructing circular buildings is an iterative process in which a process design will lead to a desired result: a circular building as resource depot. To achieve the desired results five phases are distinguished: 1) Envisioning Phase, 2) Co-Creation & Exploration Phase, 3) Experimentation Phase, 4) Execution Phase and 5) Monitoring & Evaluation. To help clients through these phases, this thesis developed a Practical Circular Building Process Facilitation Tool. This tool emphasises integral designing and co-creation by guiding them through the five phases of constructing circular buildings with a matching way of doing business. It embeds ULL principles that is focused on doing experimentations by co-creating in an open innovation process and extended the ULL with an extra step. This extra step is the execution of these experiments into practice towards a fully functioning product or service, hence, the circular building as resource depot. To facilitate the process, the tool guides the client by asking 'Yes' and 'No' question that is linear/sequential by its approach but results into circular outcomes.

For the guidance through the circular building process, two types of process flow diagrams are developed. The first type is a summarised version of the elaborated version as quick guidance for both client and consortium. It is a rough overview of the most important steps to follow when a (new) circular building project will be initiated. It helps to make quick decisions and is linked to the more elaborated process flow diagram to get a better understanding what needs to be done or what the client or consortium is missing. The elaborated process flow diagram provides the client and the consortium beside the 'Yes' or 'No' questions also with action points to help them to improve the circular building process and to make them aware what should be included. These action points are also formulated in such way that the client and the consortium still gets the freedom for interpretation, but keeping in mind that the circular vision and the commitment to follow this vision are leading. It is about aligning circularity and the vision as 'playing field' or 'building context' that stimulates new ways of thinking, triggers innovations (Bocken et al., 2015; Nevens et al., 2013; Nidumolu et al., 2009) and creating circular shared value (Porter and Kramer, 2011).

The second type is the supportive process flow diagram for both the client and the consortium. Both flow diagrams are supportive to help the client to find the right question to ask the experts, stimulate circularity and select the best matching consortium. For the consortium it is to ask the right questions in order to align and fulfil multiple needs of relevant stakeholders, enhance co-creation and triggers system innovations. It helps them both to get a better understanding what kind of question need to be asked to make sure that the aim is still on designing a circular building process.

All the questions that are formulated in the conceptual Circular Building Process Facilitation Tool are aimed to support the client and the consortium to develop circular buildings. It also gives the opportunity to be able to improve themselves by using lessons learned. If the facilitation tool will produce the intended results in practice, hence, circular buildings as resource depots, is still unclear, because it is not tested and validated yet. Nonetheless, the proposed conceptual facilitation tool has the potential to facilitate clients and consortia through the Circular Building Process in order to design and construct a Circular Building and to explore ways of doing business to do this successful. By using this tool, the transition towards CE can go quicker, because it aims to produce tangible results and setting examples. Therefore, it should stimulate the client to share their results, which will generate more knowledge and will help others to learn from it. It may even help to find new partnerships or collaborations to start new circular building projects.

7.2 Discussion

The results from the case analysis and the design workshop indicate that the current 'linear' approach of constructing buildings will needs to change to preserve resources (EEA, 2015) and reduce environmental impact by becoming more material efficient (Allwood et al., 2011). This was most noticeable in the way how tendering was being done in the three cases by asking for a building process

design in line with predefined vision and ambitions. This makes the construction of a circular building a learning process that needs to be maintained and adjusted continuously, even if it is already delivered. It is about co-designing, testing and refining until everyone agrees with the result.

By defining the ambitions, the interaction between multiple actors were very high at the beginning of the building process. During this envisioning process time and money should be invested in asking the right questions to reveal the real needs. This can be done to consult the market and ask for solutions that fit the problem. Therefore, as client, transparency and open communication were essential ingredients for collaboration within an open and competitive innovation setting. However, the problem is that the current system is not convinced yet to take the next step. As Joan Prummel (2015) of *RVO-Nederland* has noticed, everyone is still exploring and experimenting with the concept of CE and all of them have a different definition of what CE means. The issue of standardisation for having one definition of CE can be problematic for the pathway the main industry will choose to do business. Nonetheless, this is also a sign that people in different industries are seriously looking for new opportunities, because they know that a change is needed.

To move towards CE, it is about sharing knowledge and learn from each other through co-creation. This will lead to new partnerships or collaboration forms and new ways of doing business. For the collaboration part, engaging the stakeholders for innovation within a Living Lab network Leminen (2013) made the distinction between 'Top-Down' versus 'Bottom-Up' coordination and between 'Inhalation Dominated' versus 'Exhalation Dominated' participation. However, for circular building another coordination approach is applicable as well and should be included, hence, the 'Middle-Out' approach. This "Middle-Out" approach is more flexible to adjust and steer the process, because engaging stakeholders can go several ways (Janda and Parag, 2013). This was clearly applied in the circular building process of the case Alliander that did not fit well in the innovation-mechanism matrix of Leminen (2013). This was because of the intensive interactions and engagement between the stakeholders, the client/user and the consortium in several ways (see also Figure 14 in section 2.2.3).

Building on the observation of the case Alliander, the suggestion is to add an additional dimension to the innovation-mechanism matrix to explain that an in between approach is possible (see Figure 28). It will explain better that all the actors are needed to be involved in several ways (i.e. upstream, downstream and sideways) to make a circular building in a built environment successful. It will be strengthening by combining these streams and connect them according to an intermediary approach that is flexible for adjustment and create space to experiment for new solutions.

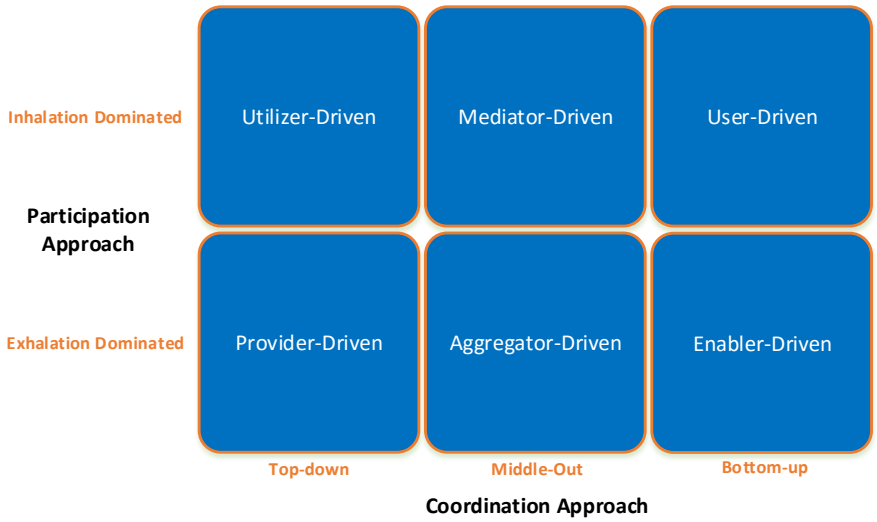


Figure 28: Proposed extended innovation-mechanism matrix by including the 'Middle-Out' approach and associated roles (derived from Leminen (2013) and extended with Janda and Parag (2013))

By adding the extra dimension, it links as well with the participatory design process of Bergvall-Kåreborn et al. (2010) to involve the users in designing a system. As the 'design for users' is focused on behalf of the users it seems that this approach is more orientated on a bottom-up coordination that is either inhalation dominated or exhalation dominated. It can be suggested that the innovation-mechanism for this participatory system design process can be 'enabler-driven' and 'user-driven'. For the 'design by user' the focus is that the user mainly assists the innovation process, by providing for example, experiences as feedback to improve a product or service. From that respect, this approach can be seen as top-down oriented, thus, 'provider-driven' and 'utiliser-driven'. With the 'design with user', the participatory system design process is focused on co-creation or co-design between stakeholders and users. This suggests that it is an iterative process where the actors can be connected in several ways and acts more as intermediaries. Therefore, the suggestion is to propose two extra roles for the actors: the mediator and the aggregator.

It is 'Mediator-driven' if the actor adopts a technology, strategy or process and adapt it in order to fit the given context. It is important to co-create/co-design with multiple actors to stimulate an iterative discussion in order to develop a collaborative design that can be adapted (Janda and Parag, 2013). Due to the needed collective action to fit a design within a certain setting, it is assumed that it is 'inhalation dominated'.

The 'aggregator-driven' is a category that can be explained as the actor that recognises and acts upon certain patterns during the designing and building trajectory based on their work experiences (Janda and Parag, 2013). Recognising and acting upon certain patterns help to sharpen the users' needs. This can be done by making them aware about what is needed and to think of strategies that are needed to be integrated into the system or circular building to fulfil the user's needs. From this perspective it is assumed as 'exhalation dominated'.

Building on ULL in correspondence with the four types of roles for actors that are distinguished by Juujärvi and Pesso (2013), some implications were found categorising these roles for the Circular Building Process. According to them ULL have four actor roles: enablers, providers, utilisers and users. Each type of actor role is needed and have their contribution to a ULL. For urban systems these roles can be clearly categorised based on the actor's contribution. However, for a Circular Building Process the role of the enablers and users is more interlinked then it can be seen as two separated roles. In fact, the enabler is usually the client that initiate a circular building process by providing and creating a strategic vision and ambitions, and is often the user or owner as well of the building. These circumstances, where the client had both the role of the enabler and user, were visible in the three cases. The local government in the case of Alliander was approached to be part of exploring and experimenting the possibilities within the law and regulations for using 'unusual' building materials. By then the role of the local government could be both of the provider or the user. As the provider, it used its knowledge to generate new knowledge for finding a solution for a specific problem. As the user, the local government was part of the user community to do experimentations in order to manage uncertainties or to overcome barriers.

From the above it is clear that actors can have different roles in a Circular Building Process. However, in this thesis it is assumed that a Circular Building Process can be seen as an ULL that act as a collaborative ecosystem, which means that a ULL becomes more dynamic in which actors can have multiple roles. Future studies should explore what the affect might be if the roles within a ULL are more dynamic. This is also in line with the finding of Juujärvi and Pesso (2013) that the multiple roles of residents (i.e. informants, testers, contributors and co-creators) are not fully understood and need to researched in future studies.

As mentioned moving towards CE, new ways of business can be developed. One particular interest in the (circular) building sector is seeing buildings as resource depots. These resource depots are focused

on preserving the use of resources, which mean for CE: closing loops and not generating any 'waste'. However, in the three cases analysed, all of them had difficulties to interpret buildings as resources depots in a business model. The Case Venlo gave stakeholders advice to include materials bookkeeping next to the traditional financial bookkeeping in order to make a forecast of what the potential future (economic) value of materials or products used could be after its usage. This idea stimulates long-term thinking for stakeholders, but the problem that stakeholders will face is uncertainty. They can do a material bookkeeping for the long-term, but what will be the added value if there is always a possibility that they will not exist anymore if the material reaches the end of it usage. The same can be asked on the viability of a resource passport, like Alliander developed for their Circular Office. The difference between bookkeeping and passport was that the latter made a documentation of all the materials and products that were being used, how much was being used and where it could be found. From this point of view, the risk might be less, because knowing what is being used and how much can be of added value for future (building materials) markets. This could be in line with the idea of an intelligent materials pooling community to manage eco-effective nutrient flow metabolism (Braungart et al., 2007). Nonetheless, the question remains if it will guarantee that the materials being used are still valuable and can be reused over again as is expected and intended to be.

What the above concepts will entail in practice is still unclear, because more companies and governance are still exploring what the possibilities are to embed a building as resource depot in a business model. The question remains how it will develop and what it will entail in the future for businesses, because the potential values of seeing buildings as resource depots are not visible yet. This can be an interesting area for future studies what the adding value (i.e. economic, environmental, societal and juridical) of a resource depot is, how it can be embedded in a business model and if it guarantees future business-proofness.

7.2.1 Potential Value of the Conceptual Circular Building Process Facilitation Tool

The need to change is not any different for the building sector that is still searching and exploring for new business opportunities and new ways of constructing buildings in a circular system. To facilitate them the proposed circular building process facilitation tool is a way to guide them to a more circular building and let them think about value creation (Section 6). This is still a conceptual tool that is not proven or tested, but has the potential to help the client and the consortium to understand what is needed to construct a (more) circular building successfully. The reason that it has potential is because of the addition of the ULL concept.

By introducing ULL, the gap between the technical part of CE and the social part of ULL can be filled. With the conceptual facilitation tool these two aspects will be linked together by guiding both the client and consortium to make use of their expertise at its fullest to create circular shared value. Therefore, the right actors need to be found and included in the process. The model that Baccarne et al. (2014) introduced to see ULL as Collaborative Ecosystem was helpful to understand which types of actors were needed to enable co-creativity and to explore the possibilities of state-of-the-art technologies in a given building context. This was a good starting point for the development of the facilitation tool to identify the actors and their interaction (Section 3.2), because buildings can also be seen as ecosystems. By thinking in ecosystems the approach of designing and building will change as well.

To govern the change, it is important to understand what the steps are and what the role of all the actors will be. In the three cases it became clear that the role and responsibilities of the experts changed. If circularity is embedded in the building process, the experts become responsible for their products because circularity means lifecycle/systems thinking. With lifecycle/systems thinking the responsibilities will be extended from the moment the resources are being extracted until it needs to be 'destroyed', hence, extended producer responsibilities (Schouten, 2014; Walls, 2006). The tool

facilitates embrace this idea to stimulate both the client and consortium to make well-thought decisions and let them think about the structure and governance of the building process.

(Urban) Living Lab concept are categorised as open innovation platforms (Almirall et al., 2012). To govern such an open innovation process for a circular building, needs an alternative structure to make this possible. What Nevens et al. (2013) argued with their Urban Transition Lab to become more sustainable in the built environment, is creating a 'comfort' zone to manage uncertainties. These uncertainties can be managed to gain quick wins and visible results/achievements. This idea to gain quick wins and visible results is to co-create with all the actors. It creates a shared language for fulfilling mutual needs in the long-term and experimenting possible solutions fitting for a circular building context (Nevens et al., 2013). This learning aspect is what the facilitation tool tries to achieve. It is giving the client and consortium questions that should trigger decision-making that is based on the creation of adding value. This way the transition towards a circular building sector can go quicker.

Furthermore, with the facilitation tool the responsibilities and intended CE based experimentation activities within the process become clear by asking question that support the iterations and interaction between the client/user, the consortium and stakeholders. This is emphasised in the way the questions are being formulated. The formulation of the questions is based on making decisions by answering them by either 'Yes' or 'No' in which each answered question leads to another step or activity (Figure 25). This is the real value of the Conceptual Circular Building Process Facilitation Tool, a sequential approach of decision-making that is focused on co-creating circular results, which entails circular shared value design proposition for realisation. The conceptual tool gives the opportunity for multiple actors to embrace the journey towards circularity. By embracing them, actors will be challenged to face the uncertainties and rethinking their design and business strategies by collecting knowledge of stakeholders and users. This will map out their needed values and match those needs as a collective group (Kristensson et al., 2008) in order to achieve their future vision. During the process more insight can be gained to understand the needed values for business. This is supported by the practical facilitation by referring to tools that are available and can be used for this purpose, for example, the 'Value Mapping Tool' for sustainable business modelling (Bocken et al., 2013), the 'Value Design Proposition' (Osterwalder et al., 2014) and the 'Product and Design Strategies' for CE (Bocken et al., 2015). In other words, the practical facilitation tool is a guidance and learning tool for both the client and consortium towards a circular building.

7.2.2 Theoretical and practical implications of the research

So far, no scientific studies linked the concept of CE with the concept of Living Labs. Studies in the field of CE is still immature, but if studies were done it was mostly related on the technical aspects and the extension of waste or material management (e.g. (Allwood, 2014; Preston, 2012; Yuan et al., 2006)). The social aspects and economic aspects were still lacking in the field of CE and only one published article of Greyson (2007) tried to include other global impacts then technical impacts and suggested that decision-making should be led by the market rather than by prescriptive regulation or educational campaigns.

For this particular research gap, the concept of Living Lab could partly fill in this gap to include the social aspects. However, the Living Lab concept itself is also relatively new and gains more attention as methodology for user involvement and open innovation (Almirall et al., 2012; Bergvall-Kåreborn, Holst, et al., 2009).

Due to the fact that both concepts are relatively new scientific research areas, finding relevant scientific articles that can connect both concepts together was challenging. In practice, some cases were already combining both concepts. To make this research possible, the case study research approach of Yin (2013) was selected to get insight and observe patterns to develop a framework that

embedded both concepts. That is also the value of this research that combines the knowledge gained form practical cases and the available scientifically knowledge appropriately.

This research adds an analytical framework to analyse a circular building process based on practical observations that is supported by scientific research to develop a practical facilitation tool. It is a start to make researchers aware to succeed a circular system that social aspects should be explored as well next to the more technical oriented aspects of CE. In practice it seems that the experts are looking for practical tools to facilitate them during a transition towards a circular system. By asking the experts during their interviews what they are looking for and mentioning the aim of this research, it shows that there is a growing interest. It seems that the development of a practical facilitation tool with a scientific base has the potential to be used. However, the developed practical circular building process facilitation tool is still a concept that need to be tested and validated if it wants to produce the intended results. For this particular reason no verdict can be given if this tool will fulfil the facilitation needs of the experts and if it will be used in practice. The same can be said of the developed analytical framework that applied ULL principles to stimulate the transition towards CE.

7.3 Recommendations for Further Research

The case study on (pilot) cases for circular buildings in section 4 provides insight in what the patterns are within a circular buildings process. These insights are also a good starting point for further research what makes a building circular, business opportunities for a circular building sector, the involvement of actors, the social aspects within CE and more in general about CE and ULL.

This thesis made a start to include social aspects and some economic aspects in the more technical oriented research of CE by developing a Circular Building Process Facilitation Tool. Therefore, social aspects and economic aspects are embedded in the tool according to the principles of ULL. As the social aspect is focused on adding value of co-creating, envisioning, learning, and involving actors as early as possible and along the process. The economic aspect is more focused on stimulating experimentations and rethinking the way of doing business that is based on circular product design and circular business model strategies.

By introducing ULL concepts to CE a ‘new’ link is made to explore the possibilities of open system innovation and ‘new’ ways of doing business in combination with CE. Given this bridge the following research is recommended:

- The Circular Building Process Facilitation Tool is still a concept and need to be tested and validated. For the validation of the tool it should be tested in other cases in the building sector for its usability and make it applicable for more organisations or sectors.
- More specifically, will this tool provide the intended results to generate new circular strategies and business models for a system transitions in general? For future work this means that cases need to be developed that test the proposed facilitation tool as a ‘standardised’ CE facilitation tool.
- The tool stimulates learning experiences during the process and help defining the vision and ambitions of the client. However, the fact remains that there is still much work to be done to structure the circular building process in a way that it truly meets the vision of the building context defined by the client. There are still many questions to be answered what the circular building process will be and what the right questions are to be asked by both the client and the consortium, see for example Actieagenda Bouw ‘*Routekaart Innovatieakkoord bouw’* (2014). This is also valid for Living Lab concepts that are applied in the concept design process in general (Bergvall-Kåreborn, Holst, et al., 2009). In other words, will it truly meet the vision with a user-driven innovation process approach in a real world context?
- The focus of the facilitation tool was on applying ULL concepts in CE on a more general level to support the building sector become more circular and explore new possibilities for business. Future work will need more elaborated research in what way ULL and CE can strengthen each

other. Especially, for business this should include other essential elements that need to be elaborated on such as the supply chain, circular procurement, enabling technologies and ICT-infrastructures (Bocken et al., 2015).

- For a Circular Building Sector, the idea of seeing buildings as resource depots become an interesting topic for companies and government. The problem is that they see the potential of a resource depot to preserve the use of resources and reduce waste, but to translate it into practice is still underexplored. Future research should study this field of interest to develop theories and concepts that help the building sector to become circular and material/resource efficient without compromising the quality of life.

For CE in general the following research is recommended:

- People know what the consequences are of their lifestyle and are aware that they need to change, however in what way they can be stimulated and influenced to change is still an area that need more research (Greyson, 2007). For CE this means in what way the 'linear' social behaviour should change in order to move towards a 'circular' social behaviour? What are the leverage points? What will be the roles of the society, companies and policies?
- Assessment methods should be developed that assess the environmental, social and economic circularity for products and business models (Bocken et al., 2015). This is related as well for finding the right CE indicators for such assessments. Geng et al. (2012) already developed a list of indicators for the national CE indicator system for China. However, as Geng et al. (2012: 223) concluded there is still research needed for CE indicators like social indicators, urban/industrial symbiosis, prevention-oriented indicators and energy/material reduction indicators. Therefore, it is interesting if a national or global indicator systems can be developed that facilitate decision-makers to make clearly defined decisions to achieve their desired outcomes.

For Urban Living Lab specific the following research is recommended:

- As suggested in the discussion, the innovation-mechanism matrix of Leminen (2013) only explained the extremes of coordinating a Living Lab network, which is top-down versus bottom-up. However, by adding the middle-out approach (Janda and Parag, 2013) an ULL can be explained better what the roles of the actors are and are needed within such a network. Building on that future research should explore this approach to see what the impact and effect will be if a middle-out approach is being used in comparison with the two extremes within an ULL.
- Constructing a building in the 'linear' system is for the client/user most of the time something that is needed, but for circularity a building will become more a personal motivation for multiple actors due to several benefits. Especially, if the building becomes a resources depot, it becomes more important to think what the future values of the building will be and in what ways adding value can be created. As Juujävi and Pesso (2013) argued when the users have the possibility to influence and shape their environment they will become intrinsically motivated to participate within the process. This commitment should be utilised to develop new methods of co-creation and participation, but this is not fully understood yet in ULL (Juujärvi and Pesso, 2013). A start to describe what the potential benefits are, when all the four actor groups (users, private, public and research) are involved, is done in this thesis, but more research for ULL is still needed to provide tangible results. In other words, what will be the economic, social and environmental benefits when the four actor groups are included?
- For proper governing urban transitions as ULL, new engagement and planning tools are needed to steer these transitions accordingly to provide multiple sustainability outcomes that also ensure that multiple sustainability goals will be achieved (social, economic and environmental) (Nevens et al., 2013).

7.4 Recommendations for Clients

As the facilitation tool is developed (Section 6), based on the findings of the case analysis (Section 4) and the Design Workshop (Section 5), some recommendations can be made that should help the practitioners to design their building process more circular, categorised as envisioning phase, co-creation and exploration phase, experimentation phase, execution phase and monitoring and evaluation.

Recommendations for the Envisioning Phase:

- When starting a new building project, define vision and ambitions in such a way that they fit with the strategy of the company or the user. This will make it personal and unique. It will also create the flexibility to ask for functional performances that also create space for interpretation. By doing so, you will not ask for a complete design of a building but a design of a process that leads to a matching building that represents your vision and ambitions.
- To design a circular building it is necessary that a multidisciplinary team will be formed that give insights from multiple perspectives. It is recommended to be open minded and consult the market as much as possible to explore the possibilities.
- As many interviewees stated, the key ingredients for a successful circular building process are integral designing and co-creation. Integral designing is a key ingredient, because it stimulates clients to think in systems and make them aware that changes in a system will affect the overall design that need to be refined or adjusted to get aligned. Co-creation is a key ingredient, because collaboration in a multidisciplinary team means exchanging knowledge between the actors to learn from and to solve a problem that benefits all, see for example the rooftop solution in the case of Alliander (Section 4.3).
- Involve a third external party that is not biased to consult and monitor the circular building process. See for example the collaboration in the Circular Office case of Alliander that involved Copper8 to facilitate them through the envisioning process and the Cradle-to-Cradle City Hall of Venlo that consulted the regional knowledge centre C2C ExpoLAB for Cradle-to-Cradle. In other words, when a circular building project will be initiated, search for a local/regional or specialised consultant to support and facilitate the Circular Building Process. This is also helpful if the third external party supports the client to make certain decisions, if necessary, for the entire trajectory.

Recommendations for the Co-Creation and Exploration Phase:

- To stimulate co-creation and make a change, actors need to be encouraged to become vulnerable and to step out of their 'comfort zone' to work together and use their expertise to support each other to make the next step.
- The best way to achieve circularity step by step is to accept that you do not know everything and should consult the market to gain the missing knowledge. This means that making mistakes or experience failures should also be seen as success if you can learn from it and do it better next time. Mistakes and failures can be analysed much easier to acknowledge what went wrong. This is more challenging with successes, because it can happen coincidental without knowing what the actual driver was that initiated its success.

Recommendations for the Experimentation Phase:

- Be critical but thoughtful when solutions are suggested. Everything can sound promising on paper or in theory, but in practice other complications or limitations may occur. It is about managing the uncertainties for proposed circular solutions. This can be revealed by keeping to ask 'Why' this solution will fit your needs, what the added value will be and if it could be done better or more circular until fully satisfied with the results. This can be achieved through trial-and-error learning.
- For business and long-term thinking it is valuable to (re)design the products in a way that it will have a positive (residual) value for the future to use it again for another cycle, hence, products that are designed to last. By doing so, reconsider your business model if it will match with your

product. If not adjust it or consider to develop a new business model, for example, from product oriented business model to functional performances oriented business model (see also PSS (Tukker, 2013)).

Recommendations for the Execution Phase:

- When the proposed circular solutions are refined enough in the experimentation phase to be executed, the translation into practice can sometimes be challenging because there is always a change that flaws in the design only reveal during execution. To find or discover these flaws it is about applying the solutions as intended and see if refinements or adjustments are needed. This sounds obvious, but again by making mistakes, a product or solution will become better each time. Keep in mind that the Circular Building Process also can be seen as a learning process.
- Seeing a building as resource depot it is recommended, to make an inventory list what materials are being used, how much is being used and where it can be found, like a building resource passport. By doing so, new opportunities can be developed for future business and will also help to think in long-term value creation for your products and materials.

Recommendations for Monitoring and Evaluation:

- Be transparent and open to communicate with the actors in order to learn from each other and to share knowledge the support each other to do better. Especially, sharing is an important driver to make progress towards a circular system. It is good to get inspired by other cases, initiatives and setting examples, but do not copy and paste. Each case, initiative or setting example is developed within a given context that is unique, because what is successful for one case does not mean it will be successful as well for another case. Therefore, it is important that you get inspired and learn from it, but tailor made for your own case of circular project by adjustments or refinements.

Bibliography

Accenture. (2014), 'Circular advantage: Innovative business models and technologies that create value', available at: http://www.accenture.com/us-en/Pages/insight-circular-advantage-innovative-business-models-value-growth.aspx (accessed 8 December 2014).

Allwood, J.M. (2014), *Handbook of Recycling*, *Handbook of Recycling*, Elsevier, available at:http://doi.org/10.1016/B978-0-12-396459-5.00030-1.

Allwood, J.M., Ashby, M.F., Gutowski, T.G. and Worrell, E. (2011), 'Material efficiency: A white paper', *Resources, Conservation and Recycling*, Elsevier B.V., Vol. 55 No. 3, pp. 362–381.

Allwood, J.M. and Cullen, J.M. (2012), *Sustainable Materials - With Both Eyes Open*, UIT Cambridge Ltd., Cambridge, UK.

Almirall, E., Lee, M. and Wareham, J. (2012), 'Mapping living labs in the landscape of innovation methodologies', *Technology Innovation Management Review*, Vol. 2 No. 9, pp. 12–18.

Almirall, E. and Wareham, J. (2008), 'Living Labs and open innovation: roles and applicability', *The Electronic Journal for for Virtual Organizations and Networks*, Vol. 10 No. 3, pp. 21–46.

van Amerongen, G. and Driessen, B. (2014), 'Anders werken anders leren in de bouw', *FNV Formaat Voorjaar 2014*, available at: http://buildupskills.otib.nl/Upload/Anders werken anders leren in de bouw.pdf (accessed 16 November 2014).

Arditi, D. and Gunaydin, H.M. (1997), 'Total quality management in the construction process', *International Journal of Project Management*, Vol. 15 No. AUGUST 1997, pp. 235–243.

Argyris, C. (1999), *On Organizational Learning*, 2nd ed., Blackwell Publishing, Cambridge, UK.

Axelsson, R., Angelstam, P., Degerman, E., Teitelbaum, S., Andersson, K., Elbakidze, M. and Drotz, M.K. (2006), 'Social and cultural sustainability: Criteria, indicators, verifier variables for measurement and maps for visualization to support planning', *Ambio*, Vol. 42 No. 2, pp. 215–228.

Ayres, R.U., Ayres, L.W. and Klöpffer, W. (1997), 'Industrial ecology: Towards closing the material cycle', *The International Journal of Life Cycle Assessment*, Vol. 2 No. 3, pp. 154–154.

Baccarne, B., Schuurman, D., Mechant, P. and De Marez, L. (2014), 'The role of Urban Living Labs in a Smart City', *XXV ISPIM Conference*, Innovation for Sustainable Economy & Society, Dublin, Ireland.

Bakker, C., den Hollander, M., van Hinte, E. and Zijlstra, Y. (2014), *Products That Last - Product Design for Circular Business Models*, TU Delft Library, Delft, the Netherlands.

Ballon, P., Pierson, J. and Delaere, S. (2005), 'Test and Experimentation Platforms for Broadband Innovation: Examining European Practice', *SSRN Electronic Journal*, available at:http://doi.org/10.2139/ssrn.1331557.

Bastein, T., Roelofs, E., Rietveld, E. and Hoogendoorn, A. (2013), *Opportunities for a Circular Economy in the Netherlands*, *Energies*, Vol. 1, TNO, Delft, the Netherlands.

Bechtel, N., Bojko, R. and Völkel, R. (2013), *Be in the Loop : Circular Economy Be in the Loop: Circular Economy & Strategic Sustainable Development*, Blekinge Institute of Technology Karlskrona, Sweden.

Beemster, W. (2012), 'Venlo Europese Hoofdstad Cradle to Cradle', *Stedebouw & Architectuur |Stedenspecial Venlo | December 2012*, December, pp. 30–31.

van den Berg, M. (2014), 'Innovatief aanbesteden met D&B focust op prestaties', *Stedebouw & Architectuur | Nummer 7 | December 2014*, December, pp. 10–11.

Berglund, H. and Sandström, C. (2013), 'Business model innovation from an open systems perspective: structural challenges and managerial solutions', *International Journal of Product Development*, Vol. 18 No. 3/4, p. 274.

Bergvall-Kåreborn, B., Holst, M. and Ståhlbröst, A. (2009), 'Concept Design with a Living Lab Approach', *Proceedings of the 42nd Hawaii International Conference on System Sciences*, IEEE, Hawaii, USA, pp. 1–10.

Bergvall-Kåreborn, B., Howcroft, D., Ståhlbröst, A. and Melander Wikman, A. (2010), 'Participation in Living Lab: Designing Systems with Users', in Pries-Heje, J., Venable, J., Bunker, D., Russo, N.L. and

DeGross, J.I. (Eds.), *Human Benefit Through the Diffusion of Information Systems Design Science Research*, Springer Berlin Heidelberg New York - IFIP International Federation for Information Processing, Berlin, Germany, pp. 317–326.

Bergvall-Kåreborn, B., Ihlström Eriksson, C., Ståhlbröst, A. and Svensson, J. (2009), 'A Milieu for Innovation – Defining Living Labs', *The Proceedings of the 2nd ISPIM Innovation Symposium*, ISPIM, New York, USA.

Blank, S. (2013), 'Why the Lean Start Up Changes Everything', *Harvard Business Review*, Vol. 91 No. 5, pp. 63–72.

Bocken, N., Short, S., Rana, P. and Evans, S. (2013), 'A value mapping tool for sustainable business modelling', *Corporate Governance: The International Journal of Business in Society*, Vol. 13 No. 5, pp. 482–497.

Bocken, N.M.P., Bakker, C. and de Pauw, I. (2015), 'Product design and business model strategies for a circular economy', Seville, Spain.

Bocken, N.M.P., Farracho, M., Bosworth, R. and Kemp, R. (2014), 'The front-end of eco-innovation for eco-innovative small and medium sized companies', *Journal of Engineering and Technology Management*, Elsevier B.V., Vol. 31, pp. 43–57.

Bocken, N.M.P., Short, S.W., Rana, P. and Evans, S. (2014), 'A literature and practice review to develop sustainable business model archetypes', *Journal of Cleaner Production*, Elsevier Ltd, Vol. 65, pp. 42–56.

van Bohemen, H. (2012), '(Eco)system Thinking: Ecological Principles for Buildings, Roads and Industrial and Urban Areas', in van Bueren, E., van Bohemen, H., Itard, L. and Visscher, H. (Eds.), *Sustainable Urban Environments: An Ecosystem Approach*, Springer Netherlands, Dordrecht, the Netherlands, pp. 15–70.

Boons, F. and Lüdeke-Freund, F. (2013), 'Business models for sustainable innovation: state-of-the-art and steps towards a research agenda', *Journal of Cleaner Production*, Elsevier Ltd, Vol. 45, pp. 9–19.

Boons, F.A.A. and Baas, L.W. (1997), 'Types of industrial ecology: The problem of coordination', *Journal of Cleaner Production*, Vol. 5 No. 1-2, pp. 79–86.

Boronowsky, M., Herzog, O., Knackfuß, P. and Lawo, M. (2006), 'Wearable Computing - an Approach for Living Labs', *Applied Wearable Computing (IFAWC), 2006 3rd International Forum on*, VDE, Bremen, Germany.

Bouw Totaal. (2014), 'Circulair en energieleverend herontwikkelingsproject', *BouwTotaal Jaargang 11 | Nummer 12*, December, No. 12, pp. 12–13.

Braam, G. (2014), 'Presentation: The re-industrialization from a Dutch Perspective', Circle Economy.

Brand, S. (1994), *How Buildings Learn: What Happens After They're Built*, Viking Press - Penguin Random House, New York, USA.

Braungart, M., McDonough, W. and Bollinger, A. (2007), 'Cradle-to-cradle design: creating healthy emissions – a strategy for eco-effective product and system design', *Journal of Cleaner Production*, Vol. 15 No. 13-14, pp. 1337–1348.

Brunner, P.H. (2011), 'Urban Mining A Contribution to Reindustrializing the City', *Journal of Industrial Ecology*, Vol. 15 No. 3, pp. 339–341.

Budweg, S., Schaffers, H., Ruland, R., Kristensen, K. and Prinz, W. (2011), 'Enhancing collaboration in communities of professionals using a Living Lab approach', *Production Planning & Control*, Vol. 22 No. 5-6, pp. 594–609.

van Bueren, E. (2012), 'Introduction', in van Bueren, E., van Bohemen, H., Itard, L. and Visscher, H. (Eds.), *Sustainable Urban Environments - An Ecosystem Approach*, Springer Netherlands, Dordrecht, the Netherlands, pp. 1–14.

Bulkeley, H., Castán Broto, V. and Maassen, A. (2011), 'Governing low carbon', in Bulkeley, H., Castán Broto, V., Hodson, M. and Marvin, S. (Eds.), *Cities and Low Carbon Transitions*, Routledge Taylor and Francis Group, London, UK and New York, USA, pp. 29–41.

C2C ExpoLAB. (2014), 'Case Study: City Hall Venlo', C2C-Centre, Venlo, the Netherlands, available at: http://www.c2c-centre.com/library-item/case-study-venlo-city-hall (accessed 1 September

2015).
Caragliu, A., Del Bo, C. and Nijkamp, P. (2011), 'Smart Cities in Europe', *Journal of Urban Technology*, Vol. 18 No. 2, pp. 65–82.
Chalmers, P. (2014), *Climate Change: Implications for Buildings - Key Findings from the Intergovernmental Panel on Climate Change Fifth Assessment Report*, Cambridge, UK, available at: http://www.gbpn.org/sites/default/files/Template AR5 - Buildings v10 - Web Pages.pdf.
Chertow, M.R. (2007), '"Uncovering" Industrial Symbiosis', *Journal of Industrial Ecology*, Vol. 11 No. 1, p. 20.
Chesbrough, H. (2006), *Open Innovation: A New Paradigm for Understanding Industrial Innovation*, edited by Chesbrough, H., Vanhaverbeke, W. and West, J.*Open Innovation: Researching a New Paradigm*, Oxford University Press, New York, USA, available at:http://doi.org/citeulike-article-id:5207447.
Chesbrough, H. (2010), 'Business model innovation: Opportunities and barriers', *Long Range Planning*, Elsevier Ltd, Vol. 43 No. 2-3, pp. 354–363.
Chesbrough, H.W. and Appleyard, M.M. (2007), 'Open Innovation and Strategy', *California Management Review*, Vol. 50 No. 1, pp. 57–76.
Circle Economy. (2015), 'The Netherlands as a circular hotspot - Circle Economy', available at: http://circle-economy.com/projects/regional/netherland-circular-hotspot/ (accessed 25 November 2015).
CoreLabs. (2008), 'CoreLabs @ TSSG', available at: http://www.tssg.org/projects/corelabs/ (accessed 15 December 2015).
Cosgrave, E. and Tryfonas, T. (2012), 'Exploring the Relationship Between Smart City Policy and Implementation', *The First International Conference on Smart Systems, Devices and Technologies Exploring*, SMART 2012, Stuttgart, Germany, pp. 79–82.
Doodeman, M. (2014), 'We willen Alliander en de hele bouw overbluffen hoever je kunt gaan', available at: http://www.cobouw.nl/nieuws/algemeen/2013/12/18/we-willen-alliander-en-de-hele-bouw-overbluffen-hoever-je-kunt-gaan (accessed 7 August 2015).
Doughty, M.R.. and Hammond, G.P. (2004), 'Sustainability and the built environment at and beyond the city scale', *Building and Environment*, Vol. 39 No. 10, pp. 1223–1233.
Edwards-Schachter, M.E., Matti, C.E. and Alcántara, E. (2012), 'Fostering Quality of Life through Social Innovation: A Living Lab Methodology Study Case', *Review of Policy Research*, Vol. 29 No. 6, pp. 672–692.
EEA. (2015), *Urban Sustainability Issues — Enabling Resource-Efficient Cities: Good Practice*, European Environment Agency, Luxembourg, Luxembourg, available at:http://doi.org/10.2800/69420.
Eisenhardt, K.M. (1989), 'Building Theories from Case Study Research', *Academy of Management Review*, Vol. 14 No. 4, pp. 532–550.
Eisenhardt, K.M. and Graebner, M.E. (2007), 'Theory Building from Cases: Opportunities and Challenges', *Academy of Management Journal*, Vol. 50 No. 1, pp. 25–32.
Ellen MacArthur Foundation. (2011), 'Case Studies: A collaborative project between Philips and TurnToo is a showcase for the pioneering "Pay-per-lux" model.', available at: http://www.ellenmacarthurfoundation.org/case_studies/philips-and-turntoo (accessed 6 February 2015).
Ellen MacArthur Foundation. (2012), *Circular Economy Report - Towards the Circular Economy Vol. 1: An Economic and Business Rationale for an Accelerated Transition*, available at: http://www.ellenmacarthurfoundation.org/publications/towards-the-circular-economy-vol-1-an-economic-and-business-rationale-for-an-accelerated-transition.
ENoLL. (2014), 'The European Network of Living Labs - the first step towards a new innovation system', available at: http://www.openlivinglabs.eu/ (accessed 1 December 2014).
Eriksson, M., Niitamo, V. and Kulkki, S. (2005), *State-of-the-Art in Utilizing Living Labs Approach to User-Centric ICT Innovation - a European Approach .*, Lulea, Sweden, available at: http://openlivinglabs.i2cat.cat/documents/SOA_LivingLabs.pdf.
Ernstson, H., van der Leeuw, S.E., Redman, C.L., Meffert, D.J., Davis, G., Alfsen, C. and Elmqvist, T.

(2010), 'Urban Transitions: On Urban Resilience and Human-Dominated Ecosystems', *AMBIO*, Vol. 39 No. 8, pp. 531–545.
European Commission. (2013), *The Opportunities to Business of Improving Resource Efficiency*, AMEC Environment & Infrastructure and Bio Intelligence Service, Northwich, Cheshire, UK.
Evans, J. and Bocken, N. (2015), 'Circular Economy Toolkit', available at: http://circulareconomytoolkit.org/Toolkit.html (accessed 3 January 2015).
Feurstein, K., Hesmer, A., Hribernik, K.A., Thoben, K.-D. and Schumacher, J. (2008), 'Living Labs: a new development strategy', in Schumacher, J. (Ed.), *European Living Labs–a New Approach for Human Centric Regional Innovation*, Wissenschaftlicher Verlag, Dornbirn, Austria, pp. 1–14.
Gitz, C. (2013), 'Turntoo en cyclisch bouwen', *De Architect | Jaargang 44 | Nummer 9*, September, pp. 79–83.
Graedel, T.E. and Allenby, B.R. (2010a), *Industrial Ecology and Sustainable Engineering*, Pearson Education, Inc., publishing as Prentice Hall, New Jersey, USA.
Graedel, T.E. and Allenby, B.R. (2010b), 'Urban Industrial Ecology', *Industrial Ecology and Sustainable Engineering*, Pearson Education, Inc., publishing as Prentice Hall, New Jersey, USA, pp. 316–340.
Greyson, J. (2007), 'An economic instrument for zero waste, economic growth and sustainability', *Journal of Cleaner Production*, Vol. 15 No. 13-14, pp. 1382–1390.
de Groot, F. (2014), 'Circulair en energieleverend herontwikkelingsproject', *Energiegids | Nummer 12*, December, pp. 25–28.
Guzman, J., Schaffers, H. and Bilicki, V. (2008), 'Living labs fostering open innovation and rural development: Methodology and results', *Proceedings of the 14th International Conference on Concurrent Enterprising*, Lisbon, Portugal, pp. 23–35.
van Hal, A. and van Bueren, E. (2012), 'Managing Change', in van Bueren, E., van Bohemen, H., Itard, L. and Visscher, H. (Eds.), *Sustainable Urban Environments: An Ecosystem Approach*, Springer Netherlands, Dordrecht, pp. 365–398.
Healey, P. (2006), 'Transforming governance: Challenges of institutional adaptation and a new politics of space1', *European Planning Studies*, Vol. 14 No. 3, pp. 299–320.
Hess, J. and Ogonowski, C. (2010), 'Steps toward a living lab for socialmedia concept evaluation and continuous user-involvement', *Proceedings of the 8th International Interactive Conference on Interactive TV&Video - EuroITV '10*, ACM Press, New York, USA, pp. 171–174.
von Hippel, E. (2005), *Democritizing Innovation*, The MIT Press, Massachusetts, USA.
Icibaci, L. and Haas, M. (2012), 'Material City: Towards Sustainable Use of Resources', in van Bueren, E., van Bohemen, H., Itard, L. and Visscher, H. (Eds.), *Sustainable Urban Environments: An Ecosystem Approach*, Springer Netherlands, Dordrecht, the Netherlands, pp. 177–204.
IPCC. (2014), *Climate Change 2014: Mitigation of Climate*, edited by Edenhofer, O., Pichs-Madruga, R., Sokona, Y., Minx, J.C., Farahani, E., Kadner, S., Seyboth, K., et al., Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA., available at: https://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_full.pdf.
Iveroth, S.P., Vernay, A.-L., Mulder, K.F. and Brandt, N. (2013), 'Implications of systems integration at the urban level: the case of Hammarby Sjöstad, Stockholm', *Journal of Cleaner Production*, Vol. 48, pp. 220–231.
Janda, K.B. and Parag, Y. (2013), 'A middle-out approach for improving energy performance in buildings', *Building Research & Information*, Vol. 41 No. 1, pp. 39–50.
Jonker, J., Tap, M. and van Straaten, T. (2012), *Nieuwe Businessmodellen. Een Exploratief Onderzoek Naar Veranderende Transacties Die Meervoudige Waarde Creëren*, Nijmegen School of Management, Nijmegen, the Netherlands.
Juujärvi, S. and Pesso, K. (2013), 'Actor Roles in an Urban Living Lab: What can we learn from Suurpelto, Finland?', *Technology Innovation Management Review*, Vol. 3 No. 11, pp. 22–27.
Khasreen, M.M., Banfill, P.F.G. and Menzies, G.F. (2009), 'Life-Cycle Assessment and the Environmental Impact of Buildings: A Review', *Sustainability*, Vol. 1 No. 3, pp. 674–701.
Koenders, D. and de Vries, S. (2015), 'Tien agendapunten voor de circulaire stad', available at: http://ruimtevolk.nl/2015/04/13/de-agenda-voor-de-circulaire-stad/ (accessed 25 November

2015).
Kohler, N. (1999), 'The relevance of Green Building Challenge: an observer's perspective', *Building Research & Information*, Vol. 27 No. 4-5, pp. 309–320.
Komninos, N., Pallot, M. and Schaffers, H. (2013), 'Special Issue on Smart Cities and the Future Internet in Europe', *Journal of the Knowledge Economy*, Vol. 4 No. 2, pp. 119–134.
Korhonen, J. (2001), 'Four ecosystem principles for an industrial ecosystem', *Journal of Cleaner Production*, Vol. 9 No. 3, pp. 253–259.
Kristensson, P., Matthing, J. and Johansson, N. (2008), 'Key strategies for the successful involvement of customers in the co-creation of new technology-based services', *International Journal of Service Industry Management*, Vol. 19 No. 4, pp. 474–491.
Kua, H.W. and Lee, S.E. (2002), 'Demonstration intelligent building - A methodology for the promotion of total sustainability in the built environment', *Building and Environment*, Vol. 37 No. 3, pp. 231–240.
Lehmann, M., Bocken, N.M.P., Steingrímsson, J.G. and Evans, S. (2015), 'Incorporating design thinking into sustainable business modelling', *Second International Conference on Sustainable Design and Manufacturing*, SDM 2015, Seville, Spain, available at: https://www.researchgate.net/publication/276269613_Incorporating_design_thinking_into_sustainable_business_modelling.
Leminen, S. (2013), 'Coordination and Participation in Living Lab Networks', *Technology Innovation Management Review*, Vol. 3 No. 11, pp. 5–14.
Leminen, S., Westerlund, M. and Nyström, A. (2012), 'Living Labs as open-innovation networks', *Technology Innovation Management Review*, Vol. 2 No. 9, pp. 6–11.
Levitt, B. and March, J.G. (1988), 'Organizational Learning', *Annual Review of Sociology*, Vol. 14, pp. 319–340.
Lievens, B., Schaffers, H., Turkama, P., Ståhlbröst, A. and Ballon, P. (2011), 'Cross border living labs networks to support SMEs accessing new markets', *eChallenges Conference Proceedings*, IIMC International Information Management Corporation, pp. 1–8.
Lifset, R. and Graedel, T.E. (2002), 'Industrial ecology: goals and definitions', in Ayres, R.U. and Ayres, L.W. (Eds.), *A Handbook of Industrial Ecology*, Edward Elgar Publishing Limited, Cheltenham, UK, pp. 3–15.
van Limpt, C. (2014), 'Duurzame overjas voor oud kantoor', *Trouw*, available at: http://www.trouw.nl/tr/nl/5009/Archief/article/detail/3594445/2014/02/11/Duurzame-overjas-voor-oud-kantoor.dhtml.
Lüdeke- Freund, F. (2010), 'Towards a Conceptual Framework of Business Models for Sustainability', *Knowledge Collaboration & Learning for Sustainable Innovation ERSCP-EMSU Conference*, Vol. 49, Harvard Business Review Press, Delft, the Netherlands, pp. 1–28.
Martinez-Balleste, A., Perez-martinez, P. and Solanas, A. (2013), 'The pursuit of citizens' privacy: a privacy-aware smart city is possible', *IEEE Communications Magazine*, Vol. 51 No. 6, pp. 136–141.
Maurya, A. (2012), *Running Lean: Iterate from Plan A to a Plan That Works*, edited by Ries, E., 2nd ed., O'Reilly Media, Inc., Sebastopol, CA, USA.
Mayers, C.K. (2007), 'Strategic, Financial, and Design Implications of Extended Producer', *Journal of Industrial Ecology*, Vol. 11 No. 3, pp. 113–131.
McDonough, W. and Braungart, M. (2010), *Cradle to Cradle: Remaking the Way We Make Things*, MacMillen Publishers, London, UK.
Mentink, B. (2014), *Circular Business Model Innovation Model*, Leiden University and Delft University of Technology.
Ministry of VROM. (2010), 'Strategieën duurzaam bouwen | Brochure | Rijksoverheid.nl', available at: https://www.rijksoverheid.nl/documenten/brochures/2010/06/01/informatieblad-strategieen-duurzaam-bouwen (accessed 15 November 2014).
Morris, M., Schindehutte, M. and Allen, J. (2005), 'The entrepreneur's business model: Toward a unified perspective', *Journal of Business Research*, Vol. 58 No. 6, pp. 726–735.
Mueller, R.M. and Thoring, K. (2012), 'Design Thinking vs Lean Startup: A Comparison of Two

Userdriven Innovation Strategies', *Proceedings of 2012 International Design Management Research Conference*, Leading Innovation Through Design, Boston, MA, USA, pp. 151–161.
Mulder, I. (2012), 'Living Labbing the Rotterdam Way : Co-Creation as an Enabler for Urban Innovation Co-Creation as an Enabler for Urban Innovation', *Technology Innovation Management Review*, Vol. 2 No. 9, pp. 39–43.
Mulder, I. and Stappers, P.J. (2009), 'Co-creating in Practice : Results and Challenges', *Proceedings of the 15th International Conference on Concurrent Enterprising*, ICE, Leiden, the Netherlands.
Mulder, I., Velthausz, D. and Kriens, M. (2008), 'The living labs harmonization cube: Communicating living lab's essentials', *The Electronic Journal for Virtual Organization & Networks*, Vol. 10 No. November, pp. 1–14.
Nevens, F., Frantzeskaki, N., Gorissen, L. and Loorbach, D. (2013), 'Urban Transition Labs: co-creating transformative action for sustainable cities', *Journal of Cleaner Production*, Elsevier Ltd, Vol. 50, pp. 111–122.
Nidumolu, R., Prahalad, C.K. and Rangaswami, M.R. (2009), 'Why sustainability is now the key of innovation', *Harvard Business Review*, Vol. 87 No. 9, pp. 57–64.
Niitamo, V.-P., Kulkki, S., Eriksson, M. and Hribernik, K.A. (2006), 'State-of-the-art and good practice in the field of living labs', *Proceedings of the 12th International Conference on Concurrent Enterprising: Innovative Products and Services through Collaborative Networks*, ICE2006, Nottingham, UK, pp. 341–348.
Ogonowski, C., Ley, B., Hess, J., Wan, L. and Wulf, V. (2013), 'Designing for the living room', *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems - CHI '13*, ACM Press, New York, USA, pp. 1539–1548.
OPAi and MVO-NL. (2014), *Ondernemen in De Circulaire Economie - Nieuwe Verdienmodellen Voor Bedrijven En Ondernemers*, Amsterdam, the Netherlands, available at: http://mvonederland.nl/nieuws/zo-plukt-u-ook-de-vruchten-van-de-circulaire-economie.
Osterwalder, A. and Pigneur, Y. (2010), *Business Model Generation*, edited by Osterwalder, A. and Pigneur, Y., John Wiley & Sons, Inc., Hoboken, New Jersey, USA.
Osterwalder, A., Pigneur, Y., Bernarda, G. and Smith, A. (2014), *Value Proposition Design*, John Wiley & Sons, Inc., Hoboken, New Jersey, USA.
Porter, M.E. and Kramer, M.R. (2011), 'Creating Shared Value', *Harvard Business Review*, No. January, pp. 1–13.
Power, A. (2010), 'Housing and sustainability: demolition or refurbishment?', *Proceedings of the ICE - Urban Design and Planning*, Vol. 163, Institution of Civil Engineers (ICE), pp. 205–216.
Preston, F. (2012), 'A Global Redesign? Shaping the Circular Economy', *Energy, Environment and Resource Governance*, No. March, pp. 1–20.
Project, T.E. (2014), *New Era. New Plan. Fiscal Reforms For An Inclusive, Circular Economy. Case Study the Netherlands*, Austerlitz, the Netherlands, available at: http://www.ex-tax.com/files/4314/1693/7138/The_Extax_Project_New_Era_New_Plan_report.pdf.
van Raaij, M. (2013), 'Meer, meer, meer!', *Architectenweb | Jaargang 1 | Nummer 2*, pp. 38–45.
Rana, P., Short, S.W. and Evans, S. (2014), 'Deliverable 2.6 Final set of tools & methods that enable analysis of future oriented, novel, sustainable, value adding business-models and value-networks', University of Cambridge, Cambridge, UK, available at: http://www.sustainvalue.eu/publications/D2_6_Final_v2.pdf.
Ravetz, J. (2008), 'State of the stock-What do we know about existing buildings and their future prospects?', *Energy Policy*, Vol. 36 No. 12, pp. 4462–4470.
Reese, H.W. (2011), 'The Learning-by-Doing Principle', *Behavioral Development Bulletin*, Vol. 17 No. 1, pp. 1–19.
Ries, E. (2011), *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses*, Crown Business.
Rifkin, J. (2008), 'The third industrial revolution', *Engineering & Technology*, Vol. 3 No. 7, pp. 26–27.
Rogers, R. (1998), *Cities for Small Planet*, Basic Books, London, UK.
Romero, D. and Flores, M. (2009), 'Towards a Novel Living Lab Model for Sustainable Innovation in the

Construction Industry', *Contribution for the 'Rapid Product Realization for Developing Markets Using Emerging Technologies*.
Rotmans, J., van Asselt, M. and Vellinga, P. (2000), 'An integrated planning tool for sustainable cities', *Environmental Impact Assessment Review*, Vol. 20 No. 3, pp. 265–276.
RVO-Nederland. (2014), 'Beleid overheid (bijna) energieneutraal bouwen | RVO.nl', available at: http://www.rvo.nl/onderwerpen/duurzaam-ondernemen/gebouwen/energieneutraal-bouwen/beleid-overheid (accessed 15 November 2014).
Sauer, S. (2013), *User Innovativeness in Living Laboratories : Everyday User Improvisations with ICTs as a Source of Innovation*, University of Twente, Enschede, The Netherlands, 18 September, available at:http://doi.org/10.3990/1.9789036500128.
Schaffers, H., Cordoba, M.G., Hongisto, P., Kallai, T., Merz, C. and van Rensburg, J. (2007), 'Exploring Business Models for Open Innovation in Rural Living Labs', *13th International Conference on Concurrent Enterprising*, Sophia-Antipolis, France, available at: http://hdl.handle.net/10204/1583.
Schaffers, H. and Kulkki, S. (2007), 'Living Labs: An open innovation concept fostering rural development', *Asia-Pacific Tech Monitor*, Vol. September-, pp. 30–38.
Schaltegger, S., Freund, F.L. and Hansen, E.G. (2012), 'Business cases for sustainability: the role of business model innovation for corporate sustainability', *International Journal of Innovation and Sustainable Development*, Vol. 6 No. 2, p. 95.
Schouten, S. (2014), *De Circulaire Economie - Waarom Productie, Consumptie En Groei Fundamenteel Anders Moeten*, Bureau de Helling, Utrecht, the Netherlands.
Schumacher, A.J. and Feurstein, B.K. (2007a), 'Living Labs — a new multi-stakeholder approach to user integration', in Gonçalves, R.J., Müller, J.P., Mertins, K. and Zelm, M. (Eds.), *Enterprise Interoperability II*, Springer London, London, UK, pp. 281–285.
Schumacher, J. and Feurstein, K. (2007b), 'Living Labs – the user as co-creator', *ICE 2007 Proceedings: 13th International Conference on Concurrent Enterprising*, The Free Press, Sophia-Antipolis, France.
Schuurman, D. and De Marez, L. (2009), 'User-centered innovation: towards a conceptual integration of lead users and Living Labs', *Proceedings of COST298-Conference The Good, The Bad and The Challenging*, COST298, Copenhagen, Denmark.
Schuurman, D., De Marez, L. and Ballon, P. (2015), 'Exploring the Impact of Methodological Set-up on Innovation Contribution in Living Labs', *XXVI ISPIM Conference: Shaping the Frontiers of Innovation Management*, ISPIM, Budapest, Hungary, available at: http://hdl.handle.net/1854/LU-6888088.
Seto, K.C., Sánchez-Rodríguez, R. and Fragkias, M. (2010), 'The New Geography of Contemporary Urbanization and the Environment', *Annual Review of Environment and Resources*, Vol. 35 No. 1, pp. 167–194.
Shafer, S.M., Smith, H.J. and Linder, J.C. (2005), 'The power of business models', *Business Horizons*, Vol. 48 No. 3, pp. 199–207.
Sosna, M., Trevinyo-Rodríguez, R.N. and Velamuri, S.R. (2010), 'Business Model Innovation through Trial-and-Error Learning', *Long Range Planning*, Vol. 43 No. 2-3, pp. 383–407.
Steentjes, A. (2013), 'Urban mining heeft toekomst met slimme ingenieurs | Intermediair.nl', available at: http://www.intermediair.nl/vakgebieden/techniek/urban-mining-heeft-toekomst-met-slimme-ingenieurs?utm_referrer= (accessed 20 February 2015).
Stubbs, W. and Cocklin, C. (2008), 'Conceptualizing a "Sustainability Business Model"', *Organization & Environment*, Vol. 21 No. 2, pp. 103–127.
Su, B., Heshmati, A., Geng, Y. and Yu, X. (2013), 'A review of the circular economy in China: moving from rhetoric to implementation', *Journal of Cleaner Production*, Elsevier Ltd, Vol. 42, pp. 215–227.
Teece, D.J. (2010), 'Business Models, Business Strategy and Innovation', *Long Range Planning*, Elsevier Ltd, Vol. 43 No. 2--3, pp. 172–194.
Telleman, A.G.M. and van den Kieboom, J.W.F. (2010), *Evaluatie van de Werking van Het Instrument*

Producentenverantwoordelijkheid in Het Afvalbeleid, RijksAdvies, the Hague, the Netherlands.
Thomke, S. and von Hippel, E. (2002), 'Customers as Innovators', *Harvard Business Review*, Vol. 80 No. 4, pp. 74–81.
Tissan, T. and Heikkila, J. (2001), 'Successful Re-engineering—Learning by Doing', *International Journal of Logistics Research and Applications*, Vol. 4 No. 3, pp. 329–344.
Trim, A. (2013), 'Richting een circulaire economie', *Architectenweb | Jaargang 1 | Nummer 2*, pp. 24–29.
Tukker, A. (2013), 'Product services for a resource-efficient and circular economy – a review', *Journal of Cleaner Production*, Elsevier Ltd, Vol. 97, pp. 76–91.
Tukker, A. and Butter, M. (2007), 'Governance of sustainable transitions: about the 4(0) ways to change the world', *Journal of Cleaner Production*, Vol. 15 No. 1, pp. 94–103.
Tukker, A., Domenech, T., Ekins, P., Jäger, J., Hartwig, F. and Kemp, R. (2014), *Policy Options for a Resource-Efficient Economy. Report about Synthesis of New Concepts.*, Vol. ENV.2012.6.3-2: EU FP7.
Walls, M. (2006), 'Extended producer responsibility and product design: economic theory and selected case studies', *Resources for the Future*, pp. 1–47.
WBCSD. (2008), *Energy Efficiency in Buildings: Facts & Trends - Business Realities and Opportunities*, Geneva, Switzerland.
WBCSD. (2009), *Energy Efficiency in Buildings: Transforming the Market*, Geneva, Switzerland.
Weijers, M. (2011), 'Stadskantoor Venlo op en top Cradle to Cradle', *Dak & Gevel Groen | Nummer 6 | Januari 2011*, pp. 24–27.
Westerlund, M. and Leminen, S. (2011), 'Managing the challenges of becoming an open innovation company: experiences from Living Labs', *Technology Innovation Management Review*, Vol. 1 No. 1, pp. 19–25.
Whyte, J. and Sexton, M. (2011), 'Motivations for innovation in the built environment: new directions for research', *Building Research & Information*, Vol. 39 No. 5, pp. 473–482.
World Economic Forum. (2014), *Towards the Circular Economy: Accelerating the Scale-up across Global Supply Chains*, World Economic Forum, Geneva, Switzerland.
Yin, R.K. (1981), 'The Case Study Crisis: Some Answers', *Administrative Science Quarterly*, Vol. 26 No. 1, p. 58.
Yin, R.K. (2013), *Case Study Research: Design and Methods*, 5th ed., Sage Publications.
Yuan, Z., Bi, J. and Moriguichi, Y. (2006), 'The Circular Economy: A New Development Strategy in China', *Journal of Industrial Ecology*, Vol. 10 No. 1-2, pp. 4–8.
Zott, C. and Amit, R. (2010), 'Business model design: An activity system perspective', *Long Range Planning*, Elsevier Ltd, Vol. 43 No. 2-3, pp. 216–226.

Appendix A: General List of Interview Questions (Dutch)

Algemene vragenlijst voor Interviews welke, afhankelijk van wie wordt geïnterviewd, kan worden aangepast.

Introductie:

1. Kunt u uzelf even kort introduceren en uw activiteiten binnen de Circulaire Economie?
2. Kunt u iets vertellen over het bedrijf en de activiteiten op het gebied van Circulaire Economie?
3. Kunt u mij wat vertellen over het project dat u vanuit de Circulaire Economie gedachtegang heeft uitgevoerd?

Circulaire Economie en Living Lab Concept[9]:

4. Wat is uw definitie van de Circulaire Economie?
5. Waarom is dit relevant voor de bouwsector?
6. Is deze definitie ook het uitgangspunt geweest voor u voor het opzetten van uw project? Zo ja, hoe hebt u dit gedaan?
7. Bent u bekent met het 'Living Lab Concept'?
8. Hoe zou u dit concept definiëren?
9. Is deze definitie ook het uitgangspunt geweest voor u voor het opzetten van uw project? Zo ja, hoe hebt u dit gedaan?

Project/Case Specifiek:

10. Wat maakt uw project bijzonder en anders ten opzichte van andere bestaande projecten?
11. Wat zijn voor u de belangrijkste resultaten, uitkomsten en lessen die u tot nu toe kunt trekken uit uw project (denk hierbij ook aan opgedane kennis en innovaties)?
12. Kunt u mij in meer detail vertellen welke stappen en beslissingen jullie hebben genomen om de belanghebbende partijen in het gehele proces, van ontwerp tot aflevering van het project, erbij te betrekken?
13. Wat voor methodes of tools heeft u gebruikt om de belanghebbende partijen nauw te betrekken bij het ontwikkelings- en validatieproces van uw producten, diensten technologieën en co-creatie te stimuleren binnen uw project?
14. Wat waren de belangrijkste methodes of tools, bijvoorbeeld ontwerptools, analytische tools of organisatorische tools, die u hebt toegepast in uw project?
15. Hoe onderhoudt u uw (zakelijke) relaties met belanghebbende partijen nadat het project is afgerond?
16. Wat voor invloed heeft het project gehad op het bedrijfsmodel van het bedrijf?

Drijfveren en Uitdagingen/Barrières:

17. Wat waren de drijfveren om de principes van de Circulaire Economie en/of Living Lab Concepten te hanteren in uw project?
18. Wat waren de uitdagingen/barrières die u aan moest gaan tijdens het project?
19. Hoe hebt u deze uitdagingen/barrières opgelost of aangepakt?

[9]Definitie Living Lab volgens de Master Thesis: *'Living Lab in de bouwsector is een systematische aanpak waarbij onderzoek en innovatie wordt geïntegreerd door samen te werken en te co-creëren met meerdere belanghebbenden (publiek-private-burger partnerschappen) met het ontwikkelen en valideren van nieuwe producten, diensten, bedrijvigheid en technologieën, die duurzame waarde creëert in een bestaande omgeving waarbij de gebruikers ook actief bij worden betrokken'.*

20. Thema Specifieke Vragen[10]

Thema	Vragen
Ontwerpproces	1. Hebt u andere ontwerpcriteria opgesteld voor uw 'circulaire project' in vergelijking met de reguliere projecten? 2. Welke voordelen ziet u in het circulair ontwerpen? 3. Hoe kunnen circulair geproduceerde producten concurreren met relatief 'goedkopere' alternatieven? (Rekening houden met extra benodigde kapitaal en bijkomende arbeidskosten)
Renovatieproces	1. Welke voordelen ziet u bij renovatie of verbouwing? 2. Hoe past dit in het Circulaire Economie gedachteging? 3. Wanneer is het commercieel aantrekkelijk om modules of componenten terug te nemen en weer te gebruiken in nieuwe goederen/producten? 4. Op welke manier wordt het aantrekkelijker om modules of componenten weer terug te winnen?
Sloopproces	1. Welke voordelen ziet u om de voorraden van bestaande gebouwen te gebruiken in plaats van nieuwe voorraden? 2. Hoe past dit in het Circulaire Economie gedachtegang? 3. Onder welke voorwaarden is het wenselijk voor bedrijven om economische prikkels te creëren voor het overgaan in het gebruik maken van bestaande materiaalvoorraden in plaats van het te vervangen met nieuwe grondstoffen? Bijvoorbeeld, hergebruiken van baksteen, cement, funderingen of andere bouwmaterialen.

Competenties en Mogelijkheden:

21. Met de kennis die u nu hebt opgedaan tijdens uw project; wat zijn de benodigde vaardigheden en competenties, als persoon, om een soortgelijk project met succes uit te voeren?
22. Welke verbeteringen/competenties waren nodig voor het bedrijf om het project succesvol in goede banen te leiden?
23. Terugkijkend op uw project, wat zou u anders hebben gedaan als u het project weer opnieuw zou doen?
24. Waar ziet u potentiele kansen voor de bouwsector in de Circulaire Economie en/of Living Lab Concepten?
25. Wat moet er gaan veranderen in de bouwsector om de transitie naar een Circulaire Economie te versnellen?
26. Wat is uw visie op hoe de Nederlandse bouwsector er moet uitzien als het circulair wordt?

Afsluiting:

27. Terugkijkend op uw hele project, kunt u in twee zinnen samenvatten hoe het ervaren hebt?
28. Tot slot, wat voor invloed heeft de overgang naar de Circulaire Economie en/of Living Lab Concept gehad op het gehele bedrijf?
29. Zijn er nog anderen dingen die u graag wilt toevoegen aan dit topic?
30. Hebt u zelf nog tips of adviezen voor andere bedrijven waarom zij zich moet richten op de Circulaire Economie?
31. Wilt u nog wat toevoegen aan onze discussie die ik misschien over het hoofd heb gezien?
32. Weet u nog andere personen wie ik zou kunnen interviewen omtrent dit onderwerp?

[10] Afhankelijk van de te interviewen bedrijf.

Appendix B: General List of Interview Questions (English)

General List of Interview Questionnaire that can be adjusted for a specific interview.

Introduction:

1. Can you introduce yourself shortly and your activities related to circular economy?
2. Can you tell me something about your organisation and its activities in circular economy?
3. Can you tell me in short about a project/case you have done in the area of circular economy?

Circular Economy and Living Lab Concepts[11]**:**

4. What is your definition of Circular Economy?
5. What is its relevance for the building sector?
6. Did you use this definition in setting up your project? If yes, how?
7. Are you familiar with the Living Lab Concepts?
8. How would you define the Living Lab Concepts?
9. Did you use this definition in setting up your project? If yes, how?

Project/Case Specific:

10. In what does makes your project/case different from other projects/cases?
11. What are main results/outcomes/lessons from your project/case (so far) (including knowledge generated and innovations)?
12. Could you describe in depth the involvement of stakeholders (i.e. public-private-civic actors) what steps and decisions you have taken from the preparation until the realisation of the project/case?
13. What methods or tools have you used to involve stakeholders (i.e. public-private-civic actors) in order to co-create, develop and validate (new) products, services, businesses and technologies during your project/case? What are major other methods applied in your project/case, e.g. design tools, analytical tools, or organisational tools)?
14. What were the most important tools or methods, for example design tools, analytical tools or management tools that are applied in your project/case?
15. How do you maintain your relationship with your stakeholders and/or users after completion of the project/case?
16. What was the effect of the project/case on the business model of the company?

Drivers and Challenges/Barriers:

17. What were the drivers to adopt the principles of circular economy and/or Living Lab concepts in your project/case?
18. What were the challenges/barriers you had faced during your project/case?
19. How did you solve those challenges/barriers?

[11]Living Lab definition used in Master Thesis: *'Living Lab in a building sector is a systematic approach that integrates research and innovation by collaborating with multiple stakeholders (public-private-civic partnerships) to co-create, develop and validate new products, services, businesses and technologies for sustainable value in real life cases in which the user is actively involved'.*

20. Theme Specific Question[12]

Theme	Questions
Design Process	1. Do you use different design criteria for your 'circular project' compared to conventional projects? 2. What do you see as the benefits of 'circular design'? 3. How can product produced in a circular way compete with relatively 'cheaper' alternatives? (e.g. consider the additional capital and labour costs of manufacturing)
Renovation/Retrofitting Process	1. What do you see as the benefits of renovation and retrofitting? How does this fit in 'circular economy thinking'? 2. When is it commercially attractive to use reclaimed modules or components in constructing new goods? 3. How can the attractiveness be increased to reclaim modules or components?
End-of-life Process	1. What do you see as the benefits of servicing existing building stocks compared to building new ones? How does this fit into 'circular economy thinking'? 2. Under what conditions would it be preferable for businesses to create economic incentives (with less new material demand than replacement demand) to derive revenue from servicing the existing stock of goods rather than aiming to replace it? For example, recycling cement, bricks or other materials.

Competencies and Opportunities:

21. With the knowledge you have gained with your project/case on circularity and/or Living Lab concepts, which skills and competencies were necessary as a person to successfully realise similar projects/cases?
22. What improvements/competencies were necessary as a company to successfully guide the realisation of the projects/cases?
23. Looking back on your project/case, what would you have done differently if you could start again?
24. Where do you see potential opportunities for circular economy and/or Living Lab concepts in the Dutch Building Sector?
25. What needs to change to support and quicken the transition to a Circular Economy in the Dutch Building Sector?
26. What is your vision on how the Dutch Building Sector should look like if it becomes circular?

Conclusion:

27. Looking back on your project/case, how would you summarise your experience in a few sentences?
28. What effect did the adoption of a circular economy and/or Living Lab concepts have on the company?
29. Are there any other things you would like to add to this topic?
30. Do you have any tips and advice for other companies why they should focus on circular economy?
31. Do you want to add anything to this discussion I may have missed?
32. Do you know any other relevant individuals I should interview about this topic?

[12] Depends on the company that is being interviewed.

Appendix C: List of Interviews

When	Who	Company	How Long	How Many	Why
20 May 2015	Maartje van den Berg	Blossom Consultancy	79 minutes	1	Owner of *Blossom Consultancy* and one of the lead project coordinators of the circular project Town Hall Brummen. This project is considered as one of the first buildings that used circular economy aspects and was innovative in the way of tendering by their ambitious design criteria and a fixed budget.
27 May 2015	Cassandra Vugts	Spark Campus	48 minutes	1	Project coordinator of *SPARK Campus* Rosmalen, a Living Lab focused on renovations and innovations in the built environment. Their main themes are health, mobility, energy and materials.
28 May 2015	Eugenie Knaap	Alliander	45 minutes	1	Project manager of the renovation and relocation of the new designed circular office of *Alliander*. This project is considered as one of the first buildings that is fully designed from sketch by using circular economy as leading concept. In addition, the way of tendering was also innovative, by using their vision and ambitions as designing criteria.
1 June 2015	Edward Timmermans	Kraaijvanger Architecten	51 minutes	1	Project coordinator of *Kraaijvanger Architecten* and responsible for the implementation of Cradle-to-Cradle City Hall Venlo and involved during the tender and design process. This project is considered to be one of the state-of-the-art buildings that is using the cradle-to-cradle principles. The tender process was innovative as well in which the client asks to architects to present a vision instead of a design for the assignment in which the cradle-to-cradle principles are emphasised.

4 June 2015	Marijn Emanuel	RAU Architecten	67 minutes	1	Architect of *RAU Architecten* and is actively involved in the project Circular Office *Alliander* and was also part of the team of project Brummen. In addition, he is also the representative of *RAU Architecten* for the Green Deals 'Circulaire Gebouwen', established by *RVO-Nederland*.
5 June 2015	Joan Prummel	RVO-Nederland	51 minutes	1	Category manager of *RVO-Nederland* and project leader of the Green Deals 'Circulaire Gebouwen'. With this Green Deals they will develop a list of key performance indicators for a circular building. Therefore, the started six pilot projects to get a better understanding about what makes a building circular and how can buidlings becomes more circular.
23 June 2015	Gert Jan de Gier	Oranje BV	58 minutes	1	Marketing Director of *Oranje BV*, a sustainable deconstruction company for the built environment that focus on sustainable recycling, renovation, asbestos removal, soil remediation, and site preparation. The company is also one of the key partners of the Green Deals 'Cirkelstad'.
14 October 2015	Anouk van der Have	Copper8	35 minutes	1	Consultant at *Copper8,* a sustainability consultancy company that believes that collaboration and co-creation are the key to make the transition towards a sustainable system. For the case *Alliander, Copper8* facilitate them to define their vision and ambitions for the market and bring multiple stakeholders together to collaborate within the process. As an independent consultancy company they monitor the process as well to give unbiased support.
		Total	**434 minutes**	**8**	

Appendix D: Full Transcription Interviews (Attachment)

Interview Transcription Details		Appendix
Interviewer	: Quinton Jie (QJ)	D-1
Geïnterviewde	: Maartje van den Berg (MB)	
Bedrijf	: Blossom Consultancy	
Project	: Huisvesting Gemeentehuis Brummen	
Datum	: 20 mei 2015	
Tijd	: 14.00u – 15.15	
Interviewer	: Quinton Jie (QJ)	D-2
Geïnterviewde	: Cassandra Vugts (CV)	
Bedrijf	: Heijmans	
Project	: SPARK Campus	
Datum	: 27 mei 2015	
Tijd	: 10.00u – 11.50u	
Bijzonderheden	: Telefonische Interview	
Interviewer	: Quinton Jie (QJ)	D-3
Geïnterviewde	: Eugenie Knaap (EK)	
Bedrijf	: Alliander	
Project	: Circulaire Herhuisvesting Kantoor Duiven	
Datum	: 28 mei 2015	
Tijd	: 16.30u – 17.30u	
Interviewer	: Quinton Jie (QJ)	D-4
Geïnterviewde	: Edwin Timmermans (ET)	
Bedrijf	: Kraaijvanger Architecten	
Project	: Stadskantoor Venlo	
Datum	: 1 juni 2015	
Tijd	: 14.00u – 15.00u	
Interviewer	: Quinton Jie (QJ)	D-5
Geïnterviewde	: Marijn Emanuel (ME)	
Bedrijf	: Rau Architecten	
Project	: Circulaire Gebouwen	
Datum	: 4 juni 2015	
Tijd	: 15.00u – 16.30u	
Interviewer	: Quinton Jie (QJ)	D-6
Geïnterviewde	: Joan Prummel (JP)	
Bedrijf	: RVO Nederland	
Project	: Green Deals Circulaire Gebouwen	
Datum	: 05 juni 2015	
Tijd	: 11.00u – 11.50u	
Interviewer	: Quinton Jie (QJ)	D-7
Geïnterviewde	: Gert Jan de Gier (GD)	
Bedrijf	: Oranje BV	
Project	: Stedelijke vernieuwing Overtoomse Veld Amsterdam	
Datum	: 23 juni 2015	
Tijd	: 09.00u – 10.00u	
Interviewer	: Quinton Jie (QJ)	D-8
Geïnterviewde	: Anouk van der Have (AH)	
Bedrijf	: Copper8	
Project	: Circulaire Herhuisvesting Alliander	
Datum	: 14 oktober 2015	
Tijd	: 10.00u – 10.30u	

Appendix E: Data Collection – Interviews

Data Source		Type of Data Source		Data Collected
Type	**Name**	**Primary Source**	**Secondary Source**	
Interview	Maartje van den Berg	**X**		**Circular Economy & Living Lab Concepts:** - Circular economy means ownership of products and materials should stay with the supplier in order to stimulate the economic interest, value during its life cycle, and re-, upcycling as much as possible. - Continuously use your products and materials sustainably. - Living Labs should be applied on a certain location. **Project/Case Specific, Town Hall Brummen:** - Create conditions based on performance during tendering process and have trust in the experts to come with (innovative) solutions. - Validation and verification of the products and materials are the responsibilities of the contractors and not of the client. - Early involvement of stakeholders saves time and money, which can be spend on sustainability. - Performance based results is embedded in contracts, this makes monitoring and evaluation on the results easier. **Drivers & Challenges:** - Circular Economy is very powerful, because the concept contains the word economy which leaves the impression that working circular business models are worth to invest, because it can be beneficial for multiple actors. - Implementing resource/materials passports - Creating good and concrete conditions for a circular design takes time and is worth to invest. **Competences & Possibilities:** - Each circular project is unique and needs its own modification, but learn from each case, get inspired and adopt what can be useful for your project. Do not copy & paste! - Monitor and evaluate performance results and not product results. - The turning point towards circularity are with the users/clients by stimulate them to ask the right questions and let them formulate their assignment/project more in terms of performance, ambitions, visions, etcetera.

				- More client/user centred and embed for example stimulation rewards when good sustainable results are achieved.
Phone Interview	Cassandra Vugts	**X**		**Circular Economy & Living Lab Concepts:** - Living Lab is project based in which multiple parties collaborate to develop new innovative ideas and test it with real users. This will speed up the upscaling which is necessary for the built environment. - Circular economy means use and produce materials in such way that it can be recycled as much as possible in other products and that waste streams are eliminated. - For the implementation, in the built environment, it is important that the technology is labelled as 'proven technology' by the government before it can be realised on large scale. For this particular reason Living Labs are ideal to support the above process. - Boosting Circular Economy needs physical space for innovation and real life testing areas. - Co-creation is key for innovation in the built environment. - Technical innovation is not the problem, it is the social, political and business acceptations that need to be taken care of. - Facilitate interdisciplinary knowledge exchange ('Kruisbestuiving'). **Project/Case Specific, SPARK Campus:** - Smart Linking experience and knowledge with multiple sectors for innovations - Before designing think of what the functionalities should be for the building. - Focus on your users and try to understand what their needs are, develop an explicit value proposition to work on and continue validating if your products or services still fit in. **Drivers & Challenges:** - Scaling up means trial-and-error learning to fine tune products and services in real life contexts. - Getting multiple stakeholders committed and aligned through stakeholder management. - Transition towards circular economy means challenge, test, validate and scaling up innovations more within Living Lab concepts. **Competences & Possibilities:** - Transparency, open mind-set and trust are key components to collaborate and co-create innovative solutions.
Interview	Eugenie Knaap	**X**		**Circular Economy & Living Lab Concepts:** - Circular economy is about material efficiency, recyclables, renewables and closing loops. **Project/Case Specific, Circular Office Alliander:** - Only put their five ambitions: 1) Building Circular, 2) Future proof working environment, 3) Develop a relationship with their neighbours and surrounding environment, 4) Energy positive location, and 5) emphasise integral approach in the market as criteria for their new office.

				- Asking the experts to use their expertise to help Alliander to come up with innovative ideas and solutions to fulfil their five ambitions of their office in an integral design. **Drivers & Challenges:** - Co-creation and integral design are key ingredients to build and succeed circular buildings. - Make a complete design proposition that tries to take everything into account before starting with the building process. Do not rush! - Involve neighbours if you want to do investment that can be beneficial for them as well, get for example purchasing advantages which can reduce financial risks. - As a user meet frequently during the designing phase with the consortia and challenge each other to get the best out of it in the final design. - As a user meet regularly during the building phase with the consortia in order to keep track on the progress and make adjustments if needed. **Competences & Possibilities:** - To think out-of-the-box dare to keep asking why we do things that way and not the other way around, and be critical when necessarily. - Multiple stakeholder dialogue at the beginning of the design process is essential to involve and align mutual benefits of stakeholders to succeed a circular building project. - The building as a resource depot and make use of resources/materials passport. - Asking the right questions to make clear what your real needs are to fulfil your vision and ambitions and get the right answers or solutions. - Take an integral approach to design and built which also considers all the ambitions that are set, and focus on performance and results.
Interview	Edward Timmermans	**X**		**Circular Economy & Living Lab Concepts:** - Cradle-to-Cradle means reuse materials as much as possible, preferable upcycling of materials, closing loops as much as possible. - Living Labs means being open, stimulate participation and fair competition. **Project/Case Specific, City Hall Venlo:** - Involvement of stakeholders at the beginning of the design process. For the tender process they also already asked contractors at the beginning to think about their product end-of-usage design. - Implementing resources/materials passports to know what the value of your resources/materials will be at the end of its usage. - To build according to the Cradle-to-Cradle principles a Cradle-to-Cradle certificate is necessary. **Drivers & Challenges:** - To make a change in mind-set towards Cradle-to-Cradle is by keep asking people why certain activities are done that way and if there is not an alternative way to do it differently.

				- Include in your design as well what the future value might be for the building or materials. Think of what the future added value will be and if you are willing to pay for that. **Competences & Possibilities:** - A DBFMO contract will be used more and more during the tender process, an extra addition will be to include residual value to make it more interesting, economic wise, for different companies and actors. - Create multiple revenue streams within your business model. - During the whole building process, from tendering to realisation, every stakeholder should be seen as equal partners despite their position and role in the process.
Interview	Marijn Emanuel	**X**		**Circular Economy & Living Lab Concepts:** - Circular economy should be accessible for everyone without compromising in the quality of life, in other words it should strive for the continuation and improving of the quality of life. - Living Labs is a testing and experimentation setting in order to make it possible to go beyond financial and regulation boundaries. - A Living Lab applied in a design process should not be seen as a process or setting in which experiments can be done on the costs of the client. It should be seen as a 'unique' process where you can learn by doing and explore new things that can be beyond your comfort zone to learn from it and make improvements. In fact, each new case or project is unique from itself in a way. Nonetheless, still your main objective is to present good results that fit with what is being asked by the client. **Project/Case Specific, Town Hall Brummen & Circular Office Alliander:** - Completed projects are your experience and are the stepping stones for the pathway you will choose to go and how you will select your next project. - Let the experts think of their own expertise in order to decide what for them most valuable might be for the future. - Involve the stakeholders as early as possible in the design process and make clear what the ambitions are and what you expect to get delivered. - Start broad and then narrow it down to details. - Let the experts think how their new product should look like in the project if you still want to fulfil your needs and the needs of the users after, for example, fifteen years. In the case of using used products the challenge will be which used products do you want to reuse and would you still be happy if it is being used for another fifteen years. **Drivers & Challenges:** - Let the market handle your questions to come with circular solutions. - Circular economy means integral approach is necessary and can be strengthen by your circular vision and ambitions.

				- Designing circular products and services and circular reuse of currently linear produced products in terms of quality and reusability is still a challenging task. - Experience by doing and have a broad sight, by looking for solutions outside your comfort zone of expertise can be fruitful as long as it fits within the characteristics of the project. - Decisions comes by experience and intuition, which results in knowledge. This results again in new or innovative solutions. - An important aspect for circularity is people's behaviour. People should be aware and educated to understand what circularity means and how they can provide their contribution to it. - Circular economy is not only to optimise material efficiency, but as well optimizing a more efficient society. - Thinking in circular design means more efficiency on different aspect such as time, finance and capacity. In other words, an efficient system. **Competences & Possibilities:** - Use knowledge about materials and products to facilitate suppliers to sell services instead of products to their users/clients. - Let the supplier be the expert, but make them aware about the advantages and possibilities of circular economy. - Circularity is a journey to experience and learn from mistakes and successes.
Interview	Joan Pummel	**X**		**Circular Economy & Living Lab Concepts:** - Circular Economy does not have a clear definition yet. If you ask 700 people to define Circular Economy, you will get 700 different answers. - To define Circular Economy, it should be defined as an economic system, where you prevent to create waste of resources by designing and using the products in such a way that recycling is something obvious to do and is economic beneficial. - Circular Economy is nothing new, but the pace and intensity to think of and do research on Circular Economy is reaching a leverage point of no return. - Everyone is still exploring and experimenting with Circular Economy and in probably 20 years, if we look back, we might find the leitmotiv of what Circular Economy may be. - Circular Economy specific for the building sector is about creating adding value and design buildings in such a way that it has multiple lifecycles. - Think in terms of circularity to find solutions to anticipate on future problems, for example, the problems that can occur when old and existing buildings will be demolished in the future. - From a technology perspective 100% circularity is possible, but from the social perspective, behaviour in particular, it is very challenging to change that because of the lock-in dependencies in our current economic system for all industries.

				Project/Case Specific, Green Deals 'Circulaire Gebouwen': - Green Deals 'Circulaire Gebouwen' is aiming to develop a building passport that clearly describes what the 'identity' of the building is, what it is made of, where the materials/products can be found precisely, what materials/products be used over and over again and how worthy the material/product values are if it is seen as a resource depot. - One of the objective of this project is to identify, with 65 participants a general list of practical circular indicators and prioritise them for assessing buildings on their circularity and its future potential or to help the building sector to make the right circular choices. - Currently there are six appointed pilot cases to test what circularity means for buildings from different starting points (new build, renovation or demolition) and what can be improved to make the step towards a circular building sector. These pilot cases will not be used to develop a general building passport, but used to learn and explore the possibilities or opportunities with the experts in the field. **Drivers & Challenges:** - Circularity is about changing the way of thinking, new forms of collaborations, sharing knowledge and open sourcing. - If you got an idea share it with everyone, it will also make you more credible. - A challenge is to aligning all the different needs of your stakeholders. - To make Circular Economy attractive it is about making and thinking big. No small scale experiments to test, but to test on a larger scale to make an impact. - Making it bigger (in volume) leads to credibility which again lead to chances and will generate more revenue. More revenue lead to more credibility which lead to new chances. - It is about just doing and see where it leads to. **Competences & Possibilities:** - Be knowledgeable about the models being used in Circular Economy, why it is important that we need a system change and that it can be beneficial. Keep in mind, however, that circular economy is not the Holy Grail, it is a hype but one with lasting effects. - Being aware and accept that Circular Economy will not have its effect or impact on every sector and must not be forced to do it this way. - Linking and bringing parties together on both knowledge and social contacts to find mutual benefits. It is about collaboration in order to fulfil each other their needs. - Success is not only about well executed projects. Failures can also be seen as successes if you can learn a lot from it and to do it better next time. In fact, mistakes and failures can be analysed very well on things what went wrong compared to very successful projects.

				- Explore the possibilities what the added values of the Circular Economy can be or are for your company.
Interview	Gert Jan de Gier	**X**		**Circular Economy & Living Lab Concepts:** - Circular Economy is about (re)using your products as the highest possible quality (upcycling), but it should be economic feasible as well. - Circular and inclusive means more attention at Sustainable Return on Investment (SROI) as well as (re)educate low-skilled, unemployed or people with disabilities to give them a (new) chance in the labour market. - For Living Lab, it is important that it is applied locally. Organise the in this case the waste flows locally to reduce the logistics and CO2-emissions. There should be organised a kind of local project sharing platform in which the projects from the region are presented in order to organise the logistics more efficiently by closing loops as much as possible within the region. **Project/Case Specific, Overtoomse Veld & Heijplaat (Green Deals 'Circkelstad'):** - In the case of Overtoomse Veld the actors are bearing the risks and are responsible to stay within their budget. This stimulate the supply chain integration with different actors and is economic beneficial for the market, because of the use of the right expertise by the right actors. - Ask the right questions during a discussion or dialogue with different parties. For example, instead of complaining about the costs or the prices, ask them to argue or to convince you why they have chosen for a certain solution. This will enhance higher output through co-creation or collaboration. So, first discus the best way to approach the problem and then discuss how to implement it accordingly through procurement. - To enhance integral value chain focus on maximizing the talents/skills of people or experts to make them better, instead on focusing skills that they have difficulty to master. - It is important for the client to find the right partners for the project and trust them they can fulfil the expectation or even beyond expectation. - Evaluate the process is important, be critical but thoughtful to improve each other. It is about learning and gaining experience to improve yourself as a company or as an expert/person, hence, trial-and-error learning. **Drivers & Challenges:** - Becoming Circular must be an intrinsic motivator for the company as well for the employees. This means a vision and ambitions to strive for and also support the society to improve the overall quality of life or social return on investment (SROI). - Economic drivers are still important, because companies want to earn money as well.

				- A challenge is to give employees/peoples the freedom to develop themselves, in other words, let them become small entrepreneurs. - Find as much as possible local solutions to stimulate reuse of materials and to reduce emissions. - Create a platform to list all the ongoing or upcoming local projects. This create transparency and will create new business opportunities, for example resource depots or efficient logistics. This could be a challenge for the government to initiate such platforms. - Current projects are evaluated and monitored on two parameters: Time and Money. Sustainability is not embedded as a parameter but it should be included as well. **Competences & Possibilities** - Utilize the talents of peoples as much as possible. - Keep improving as a company by evaluation, hence, trial-and-error learning. - Audit companies on sustainability in order to confirm if they can be considered as a sustainability focused company. - Circular building means also to think of multiple purposes or functionalities for the building during its entire life cycle.
Interview	Anouk van der Have	**X**		**Circular Economy & Living Lab Concepts:** - Circular Economy is about making smart use of your natural resources and materials and as efficient possible. - Search for a balanced system in which you do not ask for more energy and materials then needed. - For the building sector it is interesting to know and to get an overview of the materials that are being used for the construction and after its usage. **Project/Case Specific, Circular Office Alliander:** - The process of building the Circular Office Alliander was different compared to other 'sustainable/circular' buildings. - No certificate like BREEAM is being used as guiding principle for building the office. This makes a building project authentic, because then a company like Alliander can say that it is a building that is representing their vision. - It was a European Tendering, but within the European Procedure Alliander searched for possibilities how it can be done differently but still fit with the conditions as prescribed. - Copper8 asked Alliander what they really wanted with their 'new' office and why they wanted it. - Use the building not only as something that is needed, but make use of it that it represents your strategy as company. This help as well to formulate fitting ambitions.

				- Try to consult and make use of the experts in the market to define your ambitions before you put it on the market. This helps to clearly define the system boundaries. - Work with consortiums to stimulate innovation and create synergy for the final designs. - Ask open questions as much as possible to give freedom for interpretation and discussion, which stimulates co-creation. - Do not only make decisions based on cognitive intelligence but also with emotional intelligence. This will help to make a distinction between 'just another sale' story and an intrinsic committed 'let's go for it' story. **Drivers & Challenges:** - As client, try to be vulnerable but make clear what the boundaries are and try to trust in the skills and expertise of your consortium. - Make use of market consultations what the state-of-the-art developments are. - Keep asking open questions to your stakeholders to stimulate their creativity for innovations. It will also make everyone responsible for their own tasks and activities. - Keep the focus on collaboration and co-creation. - Introducing a Building tendering process that differs with the traditional way of tendering means actively involve the internal organisation in the process to get their support. - The key to make the step towards Circular Economy is collaboration. - It takes time and courage to go out of your comfort zone in order to do it differently than the usual/traditional way. **Competences & Possibilities:** - Be intrinsic motivated and committed to do it your way. - Practice what you preach. - Accept that you do not know everything. - Be vulnerable, open for challenges and be not afraid for making mistakes or face uncertainties.

Appendix F: Data Collection – Desk Research

Data Source		Type of Data Source		Data Collected
Type	**Name**	**Primary Source**	**Secondary Source**	
Case Report	C2C ExpoLab: *Case Study City Hall Venlo* (C2C ExpoLAB, 2014)		**X**	- Client translated their Cradle-to-Cradle ambitions into a programme in which their criteria for the design and construction of their new city hall is being presented. - Selection of the Design Team for the Cradle-to-Cradle City Hall Venlo. Client ask architects to present a vision based on Cradle-to-Cradle principles instead of a design as assignment. - The five best Cradle-to-Cradle visions were selected that will compete against each other, supported by the 'frontrunners' and the co-founder of Cradle-to-Cradle Prof. Dr. Braungart and McDonough + Partners of the Cradle-to-Cradle to inspire and challenge the five remaining architects to come up with their final vision. In the end the winner, after two weeks, will be selected according to criteria of the 'frontrunners'. - Design Process (Kraaijvanger Architects): o Preliminary design phase, pressure cook session to initiated the integral design process; o Monthly meeting of the design team to monitor the continuity and synergy between the disciplines. This includes the market analysis to realise the city of Venlo's requirements and ambitions for the building and motivate producers to be innovative that is based on the Cradle-to-Cradle principles; o A roadmap is being developed to achieve and fulfil the desired results and KPI's. - Cradle-to-Cradle ambitions and roadmaps plays a key role in the development of the project. - Lessons learned: o Good start is essential; o embedded circular model is leading for the policy and in the process; o a great team and shared mind-set; o Make the stakeholders responsible for their activities and make them aware of the consequences when they do not meet the ambitions; o Define measurable and practical goals for your Cradle-to-Cradle ambitions o Make your ambitions visible. o Focus on TCO and substantiate the benefits

				○ Courage and vision is essential on political and organisational level for a successive project.
Website	C2C-centre: *Stadskantoor Venlo op en top Cradle to Cradle* (Weijers, 2011)		**X**	- At the start of the design process vision and ambitions were set as criteria. - Select your design team based on shared mind-set, in this case Cradle-to-Cradle and sustainability. - Iterative process between client and design team. - During the design process also ask researchers to test if the products are viable and feasible. - Provide financial investment packages to spread out the financial risks to compensate low returns with high returns that comes with the extra investments on Cradle-to-Cradle and sustainability investments. - Do not only look for the return of investments but as well to the effect of yearly cash flows
Website Magazine	Stedebouw & Architectuur: *Stadkantoor Venlo: Cradle to Cradle ontwerpen en bouwen*		**X**	- Municipality have the ambition to become the Cradle-to-Cradle Hotspot - Kraaijvanger Architects asked demolition firms for their expertise how materials can be reused in order to close the material loops and what the residual value will be at the end-of-life of a building. - Using a third party like C2C ExpoLab to connect and link suppliers with each other to collaborate within projects and to share knowledge. - Collaborate with multiple suppliers in order to co-create innovative ideas.
Website Magazine	Stedebouw & Architectuur – Stedenspecial Venlo: *Venlo Europese Hoofdstad Cradle to Cradle* (Beemster, 2012)		**X**	- At the beginning of the year 2012 during a congress in New York, the city of Venlo was welcomed as 'Global Forerunner of Cradle-to-Cradle. - In 2007 William McDonough, Michael Braungart, the Province of Limburg and the Chamber of Commerce agreed to collaborate and make the region a Cradle-to-Cradle oriented region. - There are many Cradle-to-Cradle inspired project realised like the former Floriade Area and the 5,400-hectare area of Greenport Venlo, 'Kazernekwartier' Venlo, the multifunctional centrum of this 'Kazerne' and the City Hall Venlo. - The Venlo Principles are grounded on the three principles of Cradle-to-Cradle. These principles are put in practice by the C2C-ExpoLAB, which are: 1) diversity, 2) connect place with context, 3) combine city with nature, 4) anticipate on change, especially on innovation, 5) designing healthy systems and 6) focus on the people, because the peoples making a city.
Website Magazine	Michiel van Raaij, Architectenweb: *Meer, meer, meer!* (van Raaij, 2013)		**X**	- For the tender process Kraaijvanger proposed a plan of action instead of a concept design, in order to emphasise what a design process should look like and how this can stimulate an integral design. - At the very beginning of the design process Kraaijvanger organised what they called 'Atelierdagen', which can be described as full workshop days, in order to involve multiple stakeholders for the project, near the project location and cooperate with them to create an integral design. This approach was a success and Kraaijvanger decided to do weekly

				'Atelierdagen' instead of weekly meetings in order to react quickly on questions and proposed ideas. - Research for healthy and reusable material was the core point of the integral design process. - All the materials that is being used have its own material passport is being created. - Kraaijvanger and C2C ExpoLab have created a roadmap for the coming 15 years. This roadmap is also being used for future maintenances and for future improvements.
Magazine	Bouw Totaal: *Circulair en energieleverend herontwikkelingsproject* (Bouw Totaal, 2014; de Groot, 2014)		**X**	- Alliander formulated four ambitions for their newly renovated circular office in Duiven. - Only as a consortium (i.e. Architect, Real Estate Developer, Builder, Engineer, Interior Designer and Urban Planner) you could attend for the tender process. - It was a co-creative project in which multiple stakeholders during the design and the realisation process continuously monitoring and evaluating if things could be done more sustainable/circular.
Website	Marc Doodeman, Cobouw: *We willen Alliander en de hele bouw overbluffen hoever je kunt gaan* (Doodeman, 2014)		**X**	- Thomas Rau: "The Company (Alliander) did not asked for a product, but a process". - The selection of suppliers was based on the following question: "Do you share our ambitions or not?" - Co-creation was the key driver of the whole project. - No scheme was made in the beginning of the design process, but after a while to safeguard their chosen pathway. - The design process was considered as journey full of uncertainties, but in the end as a result you can be proud what you have built. Working this way means managing your uncertainties. In other words, do not fear uncertainties, challenges them and try to doing things differently.
Website	Cokky van Limpt, Trouw: *Duurzame overjas voor oud kantoor* (van Limpt, 2014)		**X**	- Only a consortium can apply for the assignment. Twelve applied, three have been chosen. These three consortia together, even though they were competitors, had a meeting with Alliander to discuss the ideas and how they will achieve the vision and ambitions set by Alliander. In the end Alliander choose the best match to start the circular project. Note, this process took approximately 1 year.
Website	Duurzaam Gebouwd Connect: *Verslag Duurzaam Gebouwd Op Locatie: Circulaire Economie*		**X**	- Drivers of the project were ambitions and courage. - BREEAM is not leading but a guidance and part of the contract. - Material passport will play an important role in the future economy. According to Thomas Rau buildings will be depreciated on the value of the materials that is documented.
Website Magazine	Aldo Trim, Architectenweb: *Richting een circulaire economie* (Trim, 2013)		**X**	- The ownership of all the building materials that is being used in the project Brummen stays with the supplier and producer. - During the tender process the design team was already formed in order to initiate an integral design process. In this case the knowledge of the experts can be challenged and used.

Magazine	Clairette Gitz, de Architect: *Duurzaamheid Turntoo en cyclisch bouwen* (Gitz, 2013)		**X**	- Business model Turntoo contracting based on the resource value of a product. - Building as a resource depot in which the value of materials and products are secured in a material/resource passport. Hereby, the characteristics and value for its next cycle is secured. This makes it possible to see what the performance will be when it will be reused. - For the client fixed budget and sustainability were the driver for the project. For this particular case, they decided for an open and transparent approach towards its citizens. - Tender process was based on Design & Build, which means designing and realisation are included. - The emphasis of the project specification for tendering was based on high quality, sustainability, technology, experience and usage. - No circular example anymore, due to the fact that the project in the end did not continued following the Turntoo principles by letting it go.
Magazine	Maartje van den Berg, Stedebouw & Architectuur: *Innovatief aanbesteden met D&B focust op prestaties* (van den Berg, 2014)		**X**	- By an integrated organization structure, design and realisation will be taken together. This can be seen as one iterative process and not two separated processes. - In this case this means that the contractor is team of specialists, e.g. architects, consultants, builders, constructors and engineers. - Tendering will be based on project specification in which the goal is defined as the desired results. In other words, a specification that is based on performances. - The client must let go the process and make the contractors responsible for their activities, performances and results. - A clearly defined vision for the desired results is necessarily. - In initialization phase the municipal of Brummen organised sessions with their employees, residents and companies within the municipal boundary of Brummen. During these session questions were asked to develop a vision for the semi-permanent town hall, to be proud of. - The decisive selection criteria for the case Brummen was fulfilling the ambitions sustainability goals within the strictly fixed financial framework. This had as result that innovation and creativity were the key drivers for solutions, which resulted in the 'best' value for the right price. - Next to 'Design & Build' maintenance must be included as well. This will stimulate and challenge the team of specialists as well to think about the efficiency of the building on the long term. This will result costs efficiency and maintenance efficiency.

Extra Sources:

Magazines

- Architectenweb, nummer 2 – jaargang 1 – juli 2013
  http://issuu.com/architectenweb/docs/architectenweb_magazine_2
- Rolinde Hoortje, NRC Next, nummer 132 – jaargang 8, 19-09-2013
  http://www.turntoo.com/wp-content/uploads/20130918-NRC-Next-Brummen.pdf
- Stedebouw & Architectuur, nummer 2, april 2013

Websites

- Marc Doodeman, Cobouw, 'Wij willen Alliander en de hele bouw overbluffen hoever je kunt gaan', 13-01-2014
  http://www.cobouw.nl/nieuws/algemeen/2013/12/18/we-willen-alliander-en-de-hele-bouw-overbluffen-hoever-je-kunt-gaan
- Duurzaam Gebouwd Connect, Verslag Duurzaam Gebouwd op Locatie: Circulaire Economie, 27-10-2014
  https://www.duurzaamgebouwdconnect.nl/nieuws/20141027-verslag-duurzaam-gebouwd-op-locatie-circulaire-economie-1
- Cokky van Limpt, Trouw, 'Duurzame overjas voor oud kantoor', 11-02-2014
  http://www.trouw.nl/tr/nl/5009/Archief/article/detail/3594445/2014/02/11/Duurzame-overjas-voor-oud-kantoor.dhtml
- Gerrit Tenkink, Duurzaam Gebouwd, Stadskantoor Venlo kiest voor Cradle to Cradle
  http://www.duurzaamgebouwd.nl/projecten/20150526-stadskantoor-venlo-kiest-voor-cradle-to-cradle
- C2C-Centre, Venlo City Hall
  http://www.c2c-centre.com/project/venlo-city-hall

Appendix G: Programme of the Design Workshop

Global programme Design Workshop
Duration: approximately 3 hours (180 minutes)

30 minutes for walk-in and meet at the Grand Café of RVO-NL

- To get to know each other.

10 minutes of introduction

- Introduction about why Living Lab can strengthen the transition towards Circular Economy. (5 minutes)
- Introduction about the workshop. (5 minutes)

115 minutes for the workshop itself

- Divided into two parts
    - Part 1: Living Lab and Circular Building (55 minutes)
        - What does circular building means for the Dutch Building Sector? (10 minutes)
        - What can a Living Lab deliver to Circular Building? (25 minutes)
        - What will be the effects throughout the whole Building Value & Supply Chain? (20 minutes)
            - On system innovation;
            - On process innovation;
            - On technical innovation.
- Break (10 minutes)
    - Part two 2: Right questions, right answers (55 minutes)
        - The effect of asking the right questions. (20 minutes)
        - Quest to find the right actors/stakeholders (private and public) and (end) users on the right moment. (20 minutes)
        - Business model innovation and integral co-creative design (15 minutes)

20 minutes for Conclusion and Closure

- Conclusion and discussion (15 minutes
    - What are the results?
    - What can be concluded
- Closure (5 minutes)
    - Wrap-up and short evaluation workshop
    - Follow-up steps
    - Thanking

As shown above it the global programme of the Design Workshop. For the detailed script programme of the Design Workshop, see Table 24 starting on the next page.

Table 24: Detailed Script Programme of Design Workshop

Walk-in – 30 minutes						
Time	**Research (Sub) Question**	**What**	**Why**	**How**	**Who**	**Data**
0-30 minutes		Meeting	Get to know each other.	With coffee and thee in the Grand Café of RVO Nederland	Plenary	
Introduction – 10 minutes						
Time	**Research (Sub) Question**	**What**	**Why**	**How**	**Who**	**Data**
30-35 minutes		Introduction: Why Living Lab can strengthen the transition towards Circular Economy.	Explaining that the Living Lab can help companies to make well thought decisions to start with Circular products or services.	PowerPoint Presentation	Quinton Jie	
35-40 minutes		Introduction and explaining the workshop	Tell participant what they can expect of the workshops and what we are going to do.	- PowerPoint Presentation - Post-its - Hand out pens - Flip Overs	Quinton Jie	
Result/Outcome	Introduce the participants my idea and what they can expect from the workshop.					
Workshop Part 1: Living Lab and Circular Building – 55 minutes						
Time	**Research (Sub) Questions**	**What**	**Why**	**How**	**Who**	**Data**
40-50 minutes	What do Circular Economy and Living Lab concepts mean for the Dutch Building Sector?	What does circular building means for the Dutch Building Sector? Development of a vision of circular building with the participants	Let participants think what Circular Building means for themselves.	Ask Question: What is your vision on Circular Building? Tell participant to talk with their group; discus and share thoughts	Two groups and plenary	Qualitative Data. A visualised overview of keywords that explain what a circular building

	5 min.			Learn from your group what their vision is on circular building	Let participants talk with their group members. Discus and share your vision about circular building. Let them write down some keywords.	Two groups	means in the Dutch building sector. This visualization will be used to form an integral vision in Thesis.
	5 min.			Share the keywords with the group of participants and create an overall vision of circular building	Ask the groups to share their keywords, which will be written down on a big sheet. Ask if needed some extra explanation.	Quinton Jie	
50-75 minutes		What do Circular Economy and Living Lab concepts mean for the Dutch Building Sector? What is the added value of applying living labs in circular economy?	What can a Living Lab deliver to Circular Building? Develop an overview what the value and needs are for stakeholders (private-public-civic partnerships) and (end) users.	Let participants think of how stakeholders should be organised and let them participate actively in the circular building design process.	The two groups stay the same. Ask Questions: How can stakeholders and users be involved? What are important aspects and elements? What are the real needs and added value for (end) users? Is a consortium necessarily for success? If so, on what aspect should they be selected? What about responsibilities of tasks and end results, how	Two groups	Qualitative data A table overview of values and needs of the stakeholders and (end) users that needs to be covered in the process of circular & cooperative design.

				should this need to be organised?		
	15 min.		Participants are challenged to think what it really means for stakeholders and (end) users if they want to realise the vision of circular building.	The two groups stay the same. Brainstorm session: Explore the values and needs for stakeholders and (end) users. Explore the roles of stakeholders and (end) users and their responsibilities.	Two groups	
	10 min.		Develop a scheme with values and needs.	Ask each group to share their values and needs, which will be written on a big sheet	Quinton Jie	
75-95 minutes		How can a circular building process be facilitated by living labs to improve businesses models?	What will be the effects throughout the whole Building Value & Supply Chain? Align value and needs that match and fit with the vision of circular building	To align the vision of circular building with value and needs in order to create an overview what need to change in the Value & Supply Chain on three levels of innovation: - System - Process - Technical	Categorising all the needs and value collected that fits in one of the three levels of innovation. After categorising the following questions can be asked: What need to change to steer businesses, society and political parties to fit their products or services with those values and needs? What will be the barriers that need to overcome?	Plenary and in two groups	Qualitative data Linking the vision of circular building with living labs methodology. Visualised categorisation of keywords about the changes that are needed in the value and supply chain on system level, process level and technical level.

				Will this also affect your business models?		Getting acquainted how the real values and needs are developed during an integral design process and how this process can be embedded and aligned in a tool.
	5 min.			Let the two groups write down, from their opinion, the keywords on post-its from the previous assignment to categorise the values and needs. (yellow: System) (Green: Process) (Blue: Technical)	Two groups	
	15 min.			After categorising the following questions can be asked: What need to change to steer businesses, society and political parties to fit their products or services with those values and needs? What will be the barriers that need to overcome? Will this also affect your business models?	Plenary	
Learning Objectives	- In part one of the workshops the focus is more on an abstract and system level. - How we can cooperate the vision with living lab aspects towards more concrete real values and needs. - This overview of values and needs must become tangible by thinking what is needed to change. - In the end of part one an overview is developed which is being used in part two to make concrete objectives in the form of a circular proposition design.					
Result/Outcome	- Group vision of circular building. - Scheme with value and needs. - Changes that are needed on the three levels of innovation to align the vision of circular building with the values and needs.					

Coffee/Tea Break – 10 minutes							
Workshop Part 2: Right Questions, Right Answers – 55 minutes							
Time		**Research (Sub) Question**	**What**	**Why**	**How**	**Who**	**Data**
105-125 minutes		How can businesses align values and needs of the stakeholders and the (end) user in their business model?	The effect of asking the right questions.	Share experiences with your group to learn from each other.	The group will be divided in two groups. Ask the following questions: How do you as a company as a user or as an expert formulate your questions to the market? What effect did your question on the stakeholders and/or (end) users? What was your role in the process? How transparent should you be as a company?	Two groups and plenary	Some approaches and/or methods that will tell about: - The role of stakeholders - The role of (end) users. - The role of a company.
	15 min.				Let the groups answer together the questions stated above, on a big sheet. Questions will be presented on a slide.	Two groups	
	5 min.			Share results with the each other	One person of each group will pitch in one minute their results.	Plenary	
125-145 minutes		How can businesses align values and needs	Quest to find the right actors/stakeholders	To think what is needed to form a	Ask the following questions:	Three groups and plenary	List of selection criteria to form a consortium

		of the stakeholders and the (end) user in their business model?	(private and public) and (end) users on the right moment. Share results with the each other	consortium in order to translate the values and needs into concrete solutions.	What kind of criteria or decision is needed to select your consortia? What are the phases in the designing process to decide which stakeholder needs or (end) users need to be involved? How can (end) users and stakeholders can challenge each other to get best out of it? How can you make your stakeholders and (end) users responsible for their tasks and end results during the whole designing process?		that will design and implement the end results. List of competences The iterative moments in a design process in which a stakeholder or (end) user will be participating.
	15 min.				Let the groups answer together the questions stated above, on a big sheet. Questions will be presented on a slide.	Three groups	
	5 min.			Share results with the each other	One person of each group will pitch in one minute their results.	Plenary	
145-160 minutes		How can a circular building process be facilitated by living labs to improve businesses models?	Business model innovation and integral co-creative design.	Let participants think about how a circular & cooperative design can translated into a business model. That integral co-creative design comes with certain	Ask questions: In what way will the business model be affected? Does business model need to change if you want to succeed a circular & cooperative Design? If yes, what need to change then?	Plenary	List of challenges what need to get implemented in circular business models List of competences needed to make a successive circular &

			competences needed for success.	What are the competences needed during the circular design process for the (end) users and for stakeholders/companies? Keywords will be written on a big sheet.		cooperative design before realisation.
Learning Objectives	- In part two of the workshops the focus is more on the process and technical level. - How right questions should be formulated to get a clear and concise idea what the real values and needs are in order to get the right answer, which fulfil these values and needs. - On which moments do you need the stakeholders and/or (end) users during the circular design process. - What the competences are that is needed during the circular design process.					
Results/Outcome	- Idea how a process of Circular Building Proposition Design should look like. - How business models and integral co-creative design can facilitate towards succession.					
Conclusion and Closure – 20 minutes						
Time	**Research (Sub) Question**	**What**	**Why**	**How**	**Who**	**Data**
160-170 minutes	How can the living lab be aligned with the supply and demand during the circular building design process that stimulate high quality products and/or services on the final design before implementation?	Discussion	Have a 10 minutes' discussion with the group about the results.	Ask questions: Is the idea of CBFMO+O cover things how living labs and circular economy can be applied to get a concrete and concise insights what the real values and needs are? Is it helpful to come formulate the right questions in order to get the right answers/solutions?	Plenary	Get a list of the pros and cons on the idea of CBFMO+O

170-175 minutes		Conclusion	5 minutes wrap up the results.	Recap what we have done and a short summary of the findings. Tell them what I will do with all the results. Overview of all the results and findings on the wall	Quinton Jie	An idea how a circular & cooperative design process can look like, which can be embedded in the tool to be developed.
		Wrap up the workshop	Finishing the workshop	Tell participants what the follow-up steps are. - Ask them to fill in the online feedback and evaluation form and send it to me. - Next and final workshop testing the tool Thank everyone and invite them for the drinks.	Quinton Jie	
Results/Outcome	- Overview of the findings and results on the wall. - All the sheets will be collected to save the results in a sort database. - Input for my tool.					

Appendix H: Structure of the Design Workshop

Aligning the collected data by interviews and desk research a workshop is organised to get a general idea what circular building is and in which way ULL can be complementary. The Design Workshop was inspired by the framework as introduced by Nidumolu et al. (2009). The phases of this framework is adjusted with the input of the interviews and translated in Figure 29. The approach is presented as a funnel, because by defining the overall vision the scope and boundaries can be set that emphasise to go more in depth and details by narrowing it down.

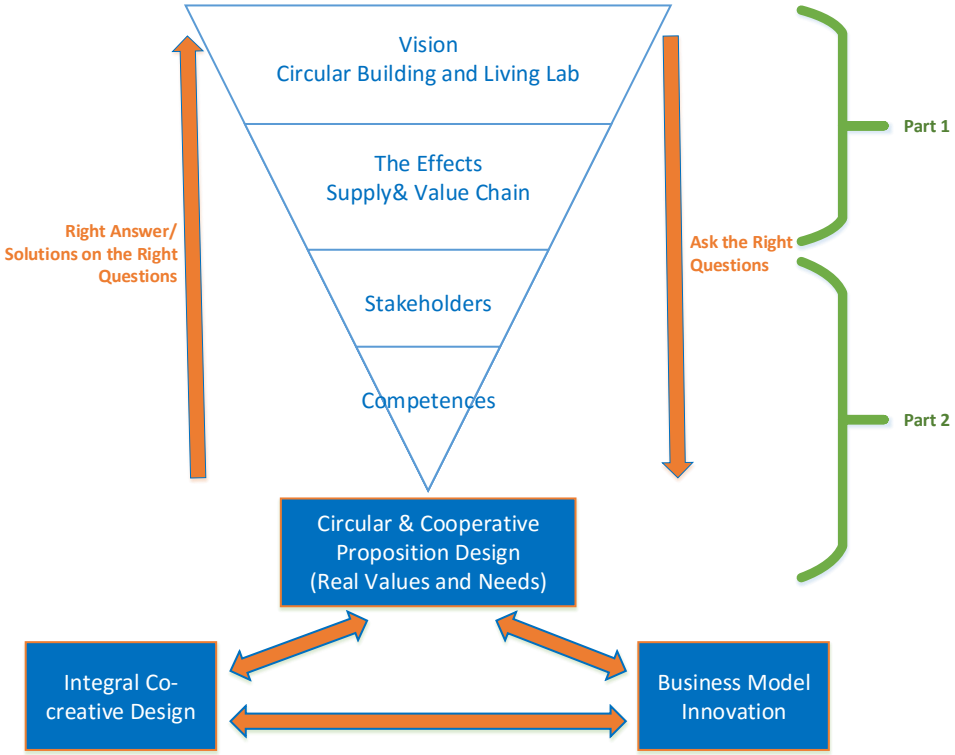


Figure 29: The process structure of the workshop from vision towards a Circular & Cooperative Proposition Design (own creation based on the interviews and the five phases framework of Nidumolu et al. (2009)).

The overall goals and the purpose of the workshops for this research, the researcher and participants are as follows:

- Research Purpose
  - Develop an integral vision with the participants what circular buildings is by using only keywords.
  - Get alignment between supply and demand between Living Lab Methodology and Circular Building in the Circular Design Process by linking the vision of circular building and the process of involving multiple stakeholders and (end) user.
  - By sharing practical experiences an idea how a process should look like to let stakeholders and (end) users think of how they can ask the right questions, and get the right answers and solutions. Therefore, it is valuable for stakeholders and (end) users to discover their real needs and value that should be achieved by integral solutions.
  - Understanding the value of Circular & Cooperative Design in order to get acquainted what the needs are to change or to improve business models.
- Personal Goals
  - To experience how a workshop is developed from sketch and how to facilitate such a workshop to get the most out of it.

    - Make the translation from theory to practice and vice versa.
    - Input for the 'Mix and Match' Tool that is valuable to improve businesses by applying Living Lab Concepts with Circular Economy.
- Participants
    - That Living Lab Concepts can strengthen businesses their value proposition to become innovative if you have deeper insights in values and needs of the (end) users and or stakeholders.
    - How to make optimal use of co-creation by actively involve stakeholders' and (end) users' values and needs through asking the right questions (i.e. what are the real core values and needs, hence, think in terms of functionality and performances) in order to get the right answers and solutions.

The overall goals and purpose of the workshop is translated into a Design Workshop which is divided into two parts. The aim of the first part was to define the macro level of a circular building sector and how it should look like. To define the overall picture of a circular building sector the following questions were asked during the workshop:

1. Vision of building circular in a circular building sector:
    a. What means building circular for the building sector?
2. From vision to supply and demands:
    a. In what way could the stakeholders (public partners, private partners and civilians) and (end-)users actively be involved within a circular and cooperative design process?
        i. What is their role?
        ii. What are the essential aspects and elements?
        iii. What are the responsibilities (activities and tasks)?
    b. What are the important demands of the (end-)users?
    c. What can be expected from the stakeholders?
3. From supply and demands to results:
    a. What need to change for companies, politics and government and society to align the products or services with the needs?

Ad 1. Vision of building circular for the building sector
In this round the vision will be defined with the participants, by asking for their circular building sector vision. The participants first discussed in couples with each other and sharing their visions for a couple of minutes. During this sharing and debating the couples were asked to write down some keywords or short statements they want to share with the whole group.

Objective: Creating a vision for a circular building sector with the participants.

Ad 2. From vision to supplies and demands
The next round a short brainstorm session with all the participants to make the circular building sector vision more concrete. Based on the keywords and short statements the task for the participants is to translate their co-created vision into supply and demand for the stakeholders and (end-)users.

Objective: Understand and reveal the real needs of the (end-)users, given the circular building sector vision and the expected role of the stakeholders to fulfil these.

Ad 3. From supply and demand to results
For the last round of part 1, participants were asked of each category: companies, politics and government and society what the changes are that are needed to translate the vision from supply and demand to concrete results. This will be helpful to reveal the barriers and challenges if a building sector want to realise the circular vision and ambitions to move towards a circular building sector.

Objective: A list of essential keywords or short statements for each category to initiate the transition towards circularity.

The second part of the workshop focused on finding the right partners to form a consortium with, which are intrinsic motivated and believes in the defined vision and ambitions to realise it accordingly. To find the right partners to form a consortium, it is essential to know and understand as a user/client what you really want and how it can be achieved. To translate this into concrete steps, an intensive collaboration process for both the user/client and stakeholders is necessary. This process is all about finding and asking the right questions to clarify the vision and ambitions into real needs before the 'best fitting' consortium can be formed to realise the project. To get a better understanding how such a process to ask the right questions and get the right answer can be facilitated the following question were used for discussion:

1. The effect of asking the right questions:
    a. How can the user/client or potential contractors can formulate the right question for the market?
    b. What are their roles by then in the process?
2. The quest of finding the right partners and users at the right moment:
    a. What are the criteria for the 'best fitting' consortium?
    b. In what way can the stakeholders and (end-)users be challenged and stimulated to make use of their full potential?
    c. What are the possibilities to make the stakeholders and (end-)users responsible for their tasks and end-results during the whole designing process?

Ad 1. The effect of asking the right questions
During this round a plenary discussion is organised to debate in what way the process can be designed in order to formulate the right questions for the market and what the effect or impact will be.

Objective: Designing a process that put emphasis on formulating and asking the right questions for the market.

Ad 2. The quest of finding the right partners and users at the right moment
In the last round of the second part of the workshop, the discussion continues on formulating the right question, but with more emphasis on finding the right partners to answer these questions. Finding the right partners and approach them at the right moment is a time consuming task. By doing so this round tries to make this clear and what steps should be taken.

Objective: Mapping the criteria for the 'best fitting' consortium and the right moment to approach the stakeholders or talents in order to make full use of their skills and expertise.

Appendix I: Full List of Challenges to be Faced for Change

In the Table 25 below the full list of the important challenges that needs to be faced by companies, politics and government and society in order to move towards a circular building sector. The list is being put together by the participants of the organised Design Workshop.

Table 25: Full list of important challenges that needs to be faced by companies, politics and government and society.

Companies	Politics and Government	Society
- Integral thinking (bigger/wider than organisation); - Total Value Usage instead of Total Cost of Ownership; - Trust and collaborate with market; - Sharing knowledge equals learning together; - Transparency; - Performance based models instead of price based models; - Accept that you do not know everything; - Rethink, Redesign; - Innovation; - Transition: - Formulate the 'new' tendering; - Usage of the building; - Courageous; - No KPI culture, but shared value; - Add health of people; - Take the lead.	- Challenge the market (public and private) for new forms of tendering; - Be open and flexible for change; - Take a more facilitative and supportive role for companies; - More flexible regulations for circular innovations; - Courageous; - Take the lead; - Be the setting example as government; - Information and communication; - Be a platform to enhance collaboration; - Create space within the tendering procedure; - Social Responsibility for public space; - Change regulations in general.	- Involvement as equal partner in the process; - A source of knowledge to set social objectives or ambitions; - Products as service instead of owning products; - The building should add value for the surrounding environment. - Learn to share or to reuse products; - Tolerance; - Open connected; - Building adds value for the surrounding environment; - Take the lead; - Inclusive (Labour market).

Appendix J: Formulation of the Question for the Tool

For the Circular Building Process Facilitation Tool and the additional supportive facilitation tool for both the client and consortium, process flow diagrams as guidance are developed to support the participants to make decisions that are circular and value based. Therefore, a list of "yes" or "no" questions is being arranged. These questions are all based on the findings of the interviews, case analysis and literature. The list of questions and their source(s) can be found in the Tables 26, 27 and 28. To note, the green approval marks were given if it was discussed and if a clear pattern were found.

For the interviews/workshops the green approval marks were given if it was discussed during the interviews or the workshop. For the case analysis the green approval marks were given if there were similarities or differences found in the cross-case analysis and can be assumed as a clear pattern. The literature with corresponding references were used if a topic was missing or if it was supportive and validating the question that it is necessary to ask. The colour of the questions corresponds with the colour of the process flow diagrams as presented in Chapter 6.

The inspiration and the formulation of the questions, all the interviews are analysed in combination with the summarised results of the workshop (Chapter 5) and the patterns found in the cross-case analysis (Section 4.4). Literature as source was for the topics that were not clear in either the interview or case analyse, if topics were missing (not (clearly) discussed in interviews/workshop or no clear pattern found in case analysis, but necessary to include) and/or to validate or to support the questions.

Table 26: List of questions asked in the summarised Circular Building Process Facilitation Tool.

Circular Building Process Facilitation Tool - Summarised				
	Question	Source		
		Interview/ Workshop	Case Analysis	Literature
Envisioning Phase	Circular Economy vision & ambitions defined that is representing the company's strategy?	√	√	X
	Involved multidisciplinary internal and external organisations?	√	√	(Baccarne et al., 2014; Nevens et al., 2013)
	The Building Context defined?	√	√	(Osterwalder et al., 2014)
	Asked for a design of the circular building process?	√	√	(Blank, 2013)
	Stimulated an open competition?	X	√	(Nevens et al., 2013)
	Formed the consortium?	√	√	(Nevens et al., 2013)
Co-Creation & Exploration Phase	Are contracts signed?	√	√	X
	Are the roles and responsibilities of the Client and the Consortium clearly defined?	√	√	X
	Are regular open meetings organised to involve the users and relevant stakeholders as early as possible?	√	X	X
	Are all the relevant actors actively participating and collaborating as one ecosystem?	X	X	(Baccarne et al., 2014)

	Circular shared value design proposition created?	√	√	(Osterwalder et al., 2014; Porter and Kramer, 2011)
	Is it clear how the collaboration and innovation process will be governed by either the client or the consortium?	X	X	(Leminen, 2013; Nevens et al., 2013)
Experimentation Phase	Do the consortium got the freedom to experiment in order to create adding value?	X	√	X
	Do the client and the consortium enhance co-creativity and integral designing?	√	√	X
	Are the products or materials being used or developed that are long lasting?	√	√	(Bakker et al., 2014; Bocken et al., 2015)
	Are there regular re-evaluation assessments organised to do even better if possible?	√	X	(Blank, 2013)
	Is circular value created for both client/user and the business?	X	X	(Bocken et al., 2013; Osterwalder et al., 2014; Porter and Kramer, 2011)
	Is the way of doing business (Product design and business model) based on circularity?	X	X	(Bocken et al., 2015; Nidumolu et al., 2009)
Execution Phase	Are failures and making 'mistakes' by 'just-doing-it' allowed?	√	X	X
	Are the products or materials being used or developed long lasting?	√	X	(Bakker et al., 2014)
	Is there a precise inventory of the amount being used and the whereabouts of the materials/products/resources?	√	X	X
Monitoring	Are all the relevant actors intrinsic committed and open to learn, experiment and adapt?	√	√	X
	Do failures and mistakes means learning and is there space created for improvements?	√	√	(Blank, 2013; Nevens et al., 2013)
	Reduced uncertainties and minimised risks by doing?	X	X	(Blank, 2013; Guzman et al., 2008; Nevens et al., 2013; Osterwalder et al., 2014)
Evaluation	Are the results beyond expectations?	X	√	X
	Will there be evaluation sessions or interviews organised with the consortium and the involved actors?	√	X	X
	Will the experiences and the results be published and actively shared?	X	√	X

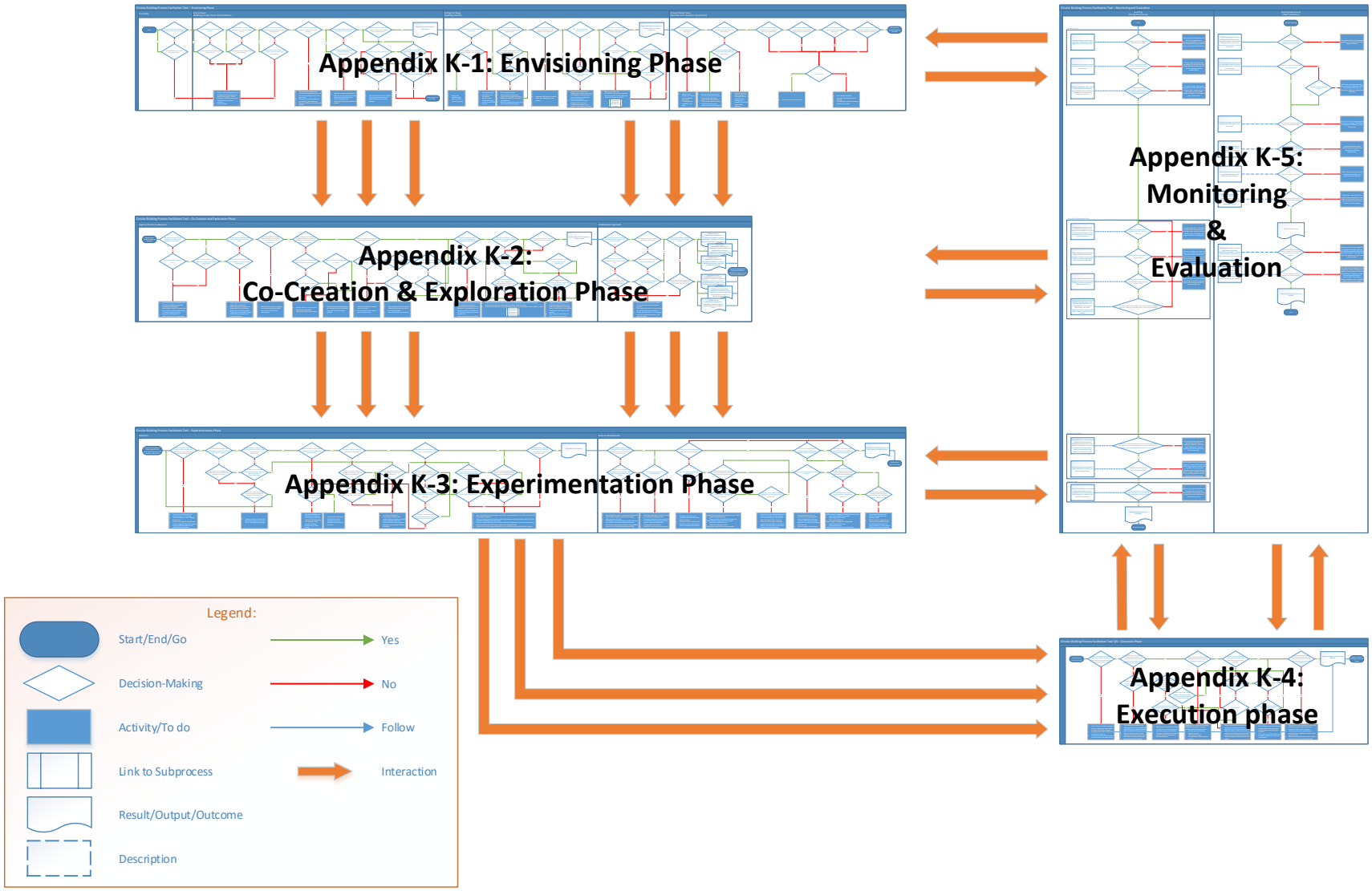
Table 27: List of questions asked in the additional Circular Building Process Facilitation Tool for the Client.

Circular Building Process Facilitation Tool – For the Client			
Question	Source		
	Interview/ Workshop	Case Analysis	Literature
Did your formulated the circular vision and ambitions for a circular building that is representing your strategy?	√	√	X
Have you thought about what you might expect to happen with the building, for example, in the coming 20 years?	√	√	X
Do the circular vision and ambitions aim to improve the quality of life?	X	√	(Allwood, 2014; Baccarne et al., 2014; Edwards-Schachter et al., 2012; Nevens et al., 2013)
Have you thought about how to preserve the value of the products and materials used on the long term in a building?	√	√	(Schouten, 2014)
Are you critical but realistic when solutions are proposed?	√	X	X
Are all the previous asked questions based on adding value and functional performances?	√	√	(Tukker, 2013)
Are you fully satisfied that it will fulfil your needs and ambitions?	X	X	(Osterwalder et al., 2014)

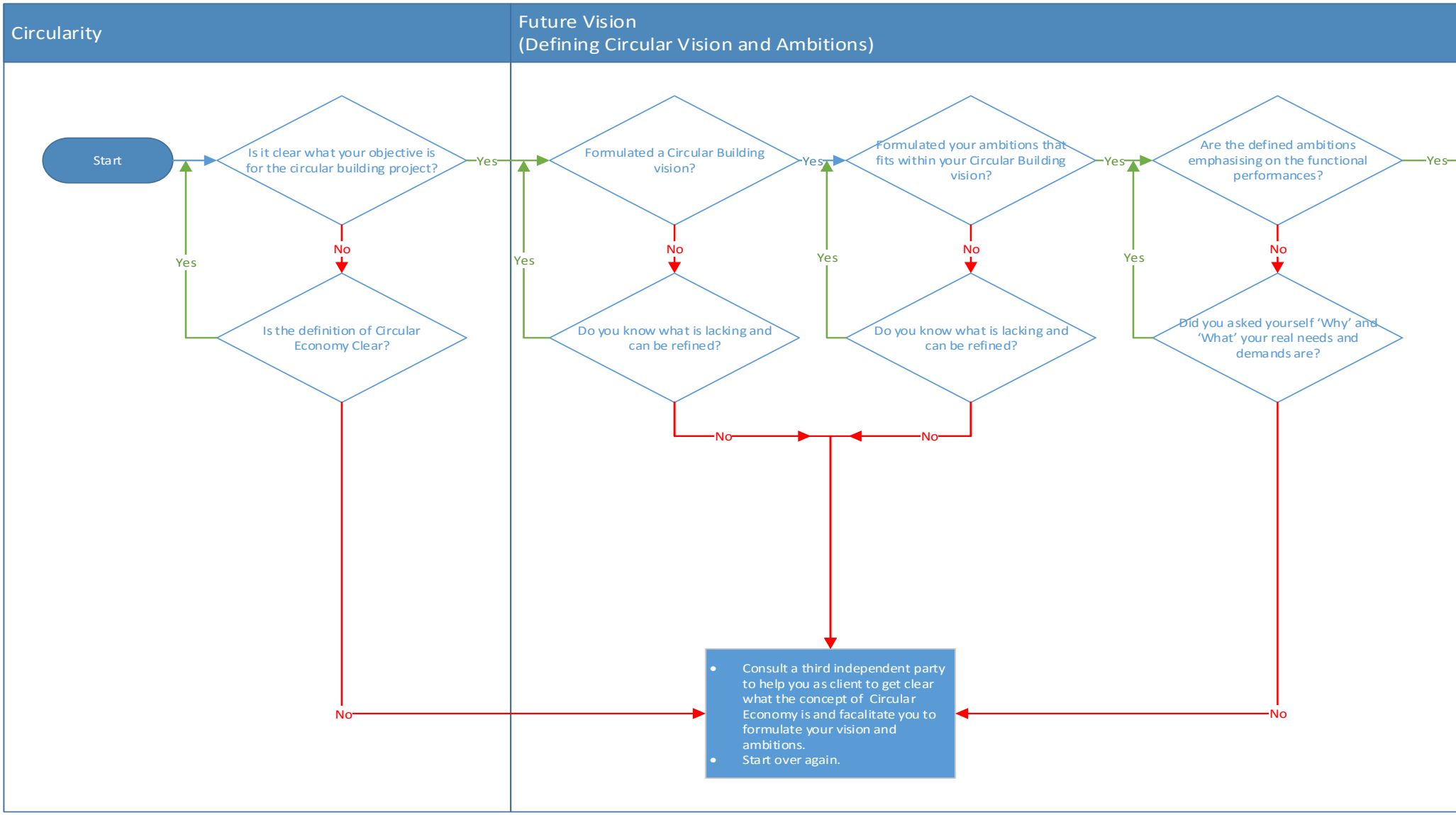
Table 28: List of questions asked in the additional Circular Building Process Facilitation Tool for the Consortium (i.e. Multidisciplinary Design and Built Team selected by the Client).

Circular Building Process Facilitation Tool – For the Consortium			
Question	Source		
	Interview/Workshop	Case Analysis	Literature
Do the ambitions of the client/user give the freedom and space for interpretation?	√	X	X
Is it clear what the mutual benefits are for suppliers, producers and contractors?	√	X	(Bergvall-Kåreborn, Ihlström Eriksson, et al., 2009)
Did you made clear that the responsibilities and ownership will stay with the suppliers, producers and contractors?	√	√	(Schouten, 2014)
Are the suppliers, producers and contractors focused on the functional performances of their products?	√	√	(Schouten, 2014; Tukker, 2013)
Are the products produced aiming to close the loops within the supply/value chain?	X	√	(Ellen MacArthur Foundation, 2012; Preston, 2012; World Economic Forum, 2014)
Did you make an aligned list of the priorities of all the stakeholders and client/user's their needs and benefits?	X	X	(Osterwalder et al., 2014)

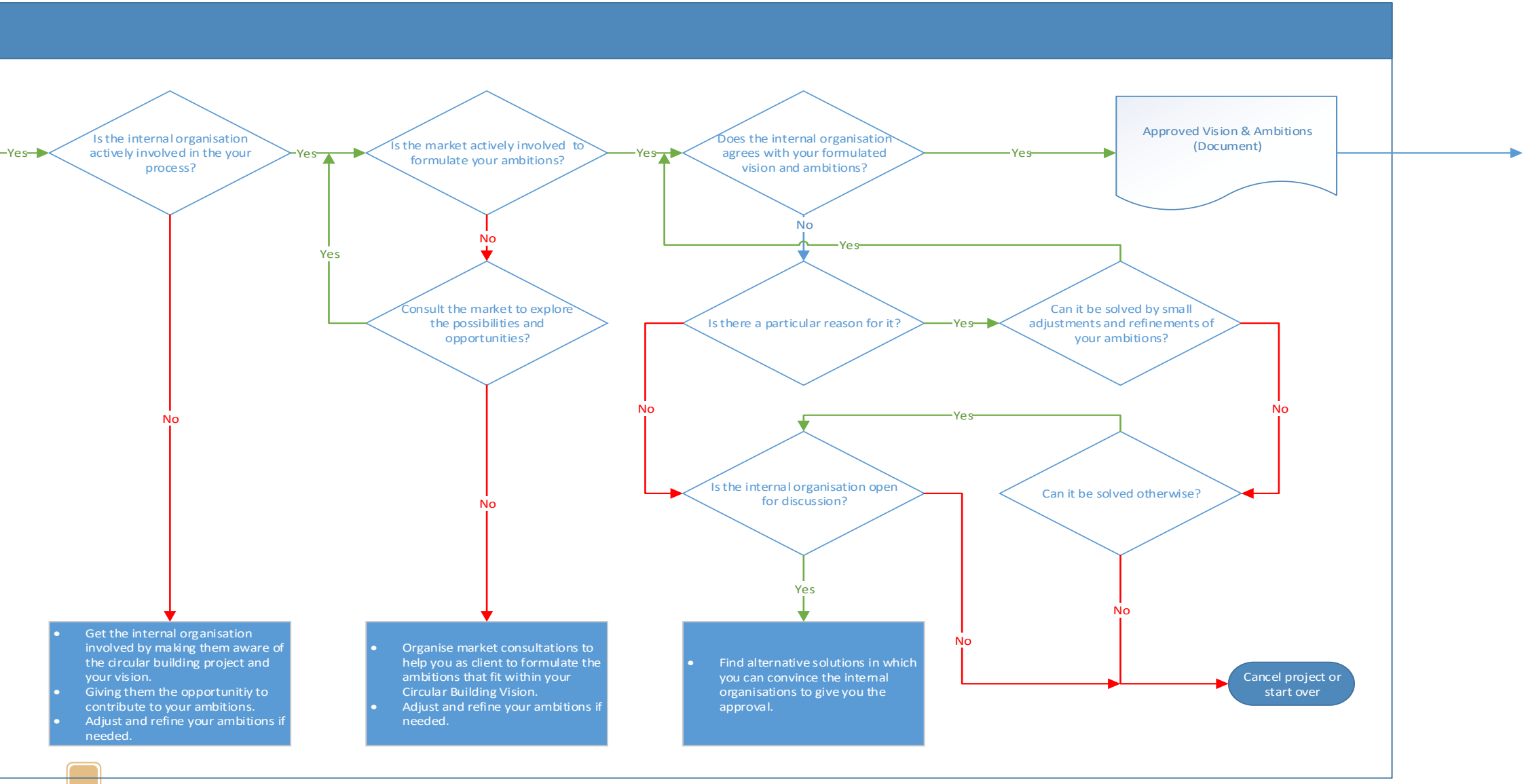
Appendix K: The Conceptual Circular Building Facilitation Tool



Appendix K-1: Envisioning Phase

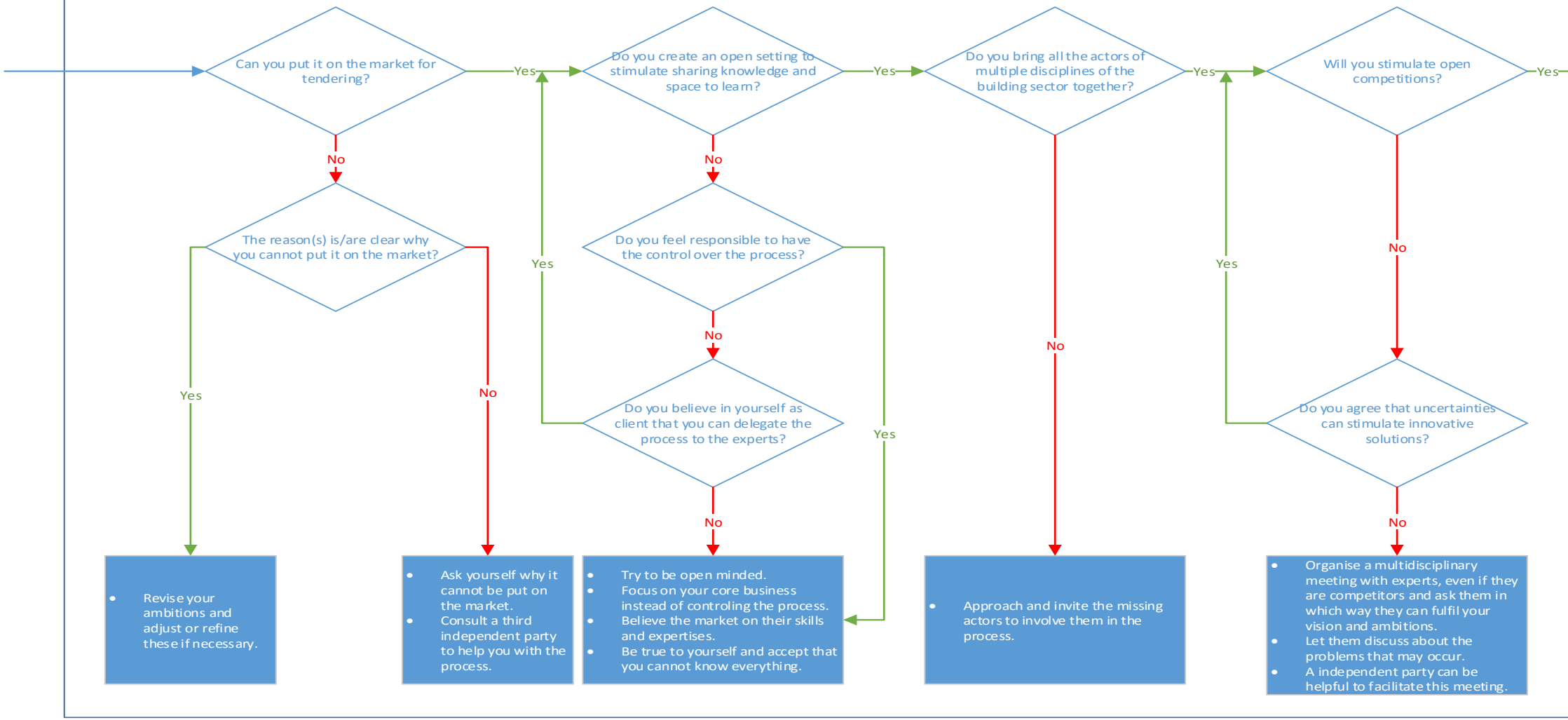


Envisioning Phase

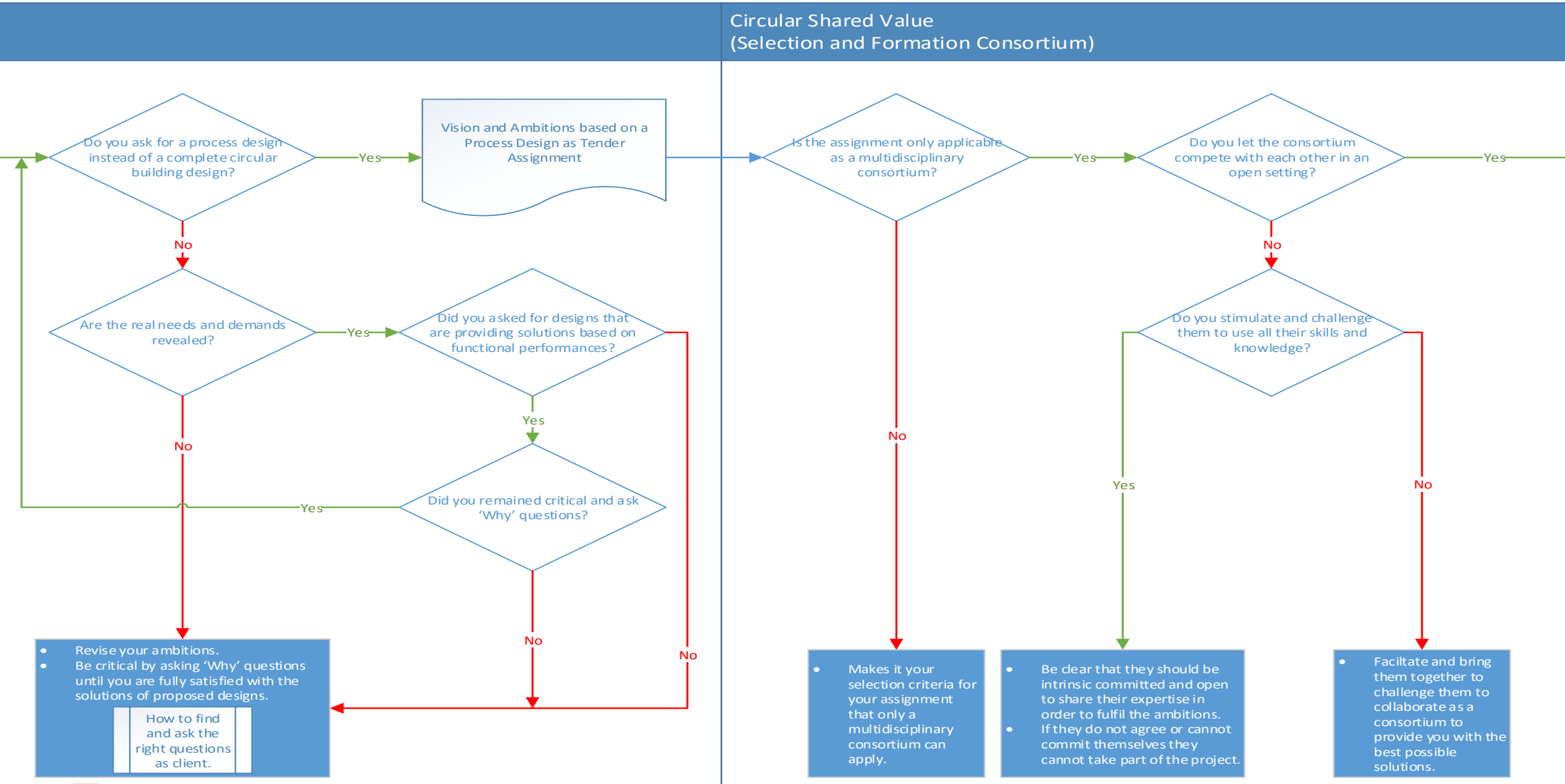


Envisioning Phase

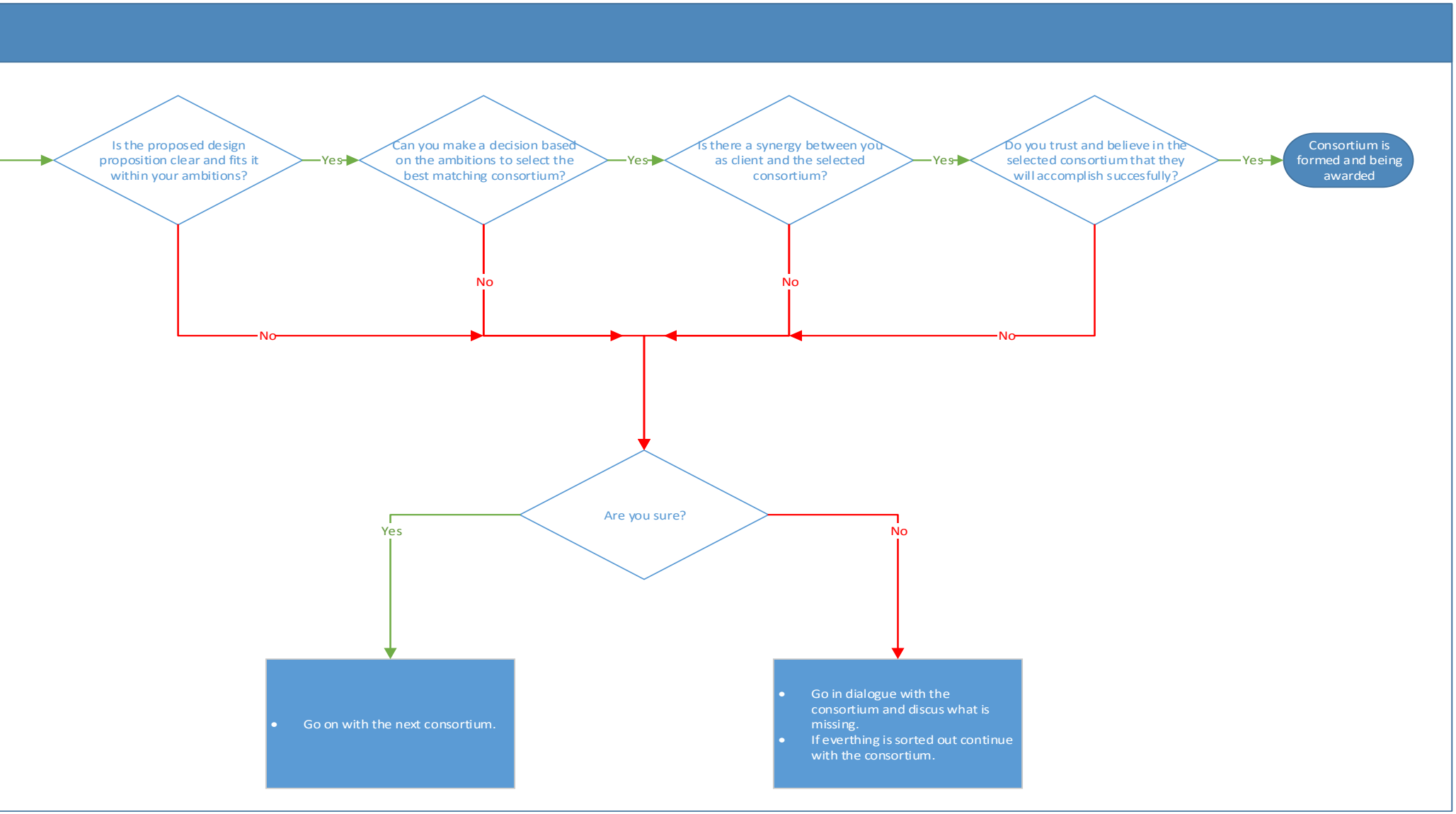
Setting the Stage (Building Context)



Envisioning Phase

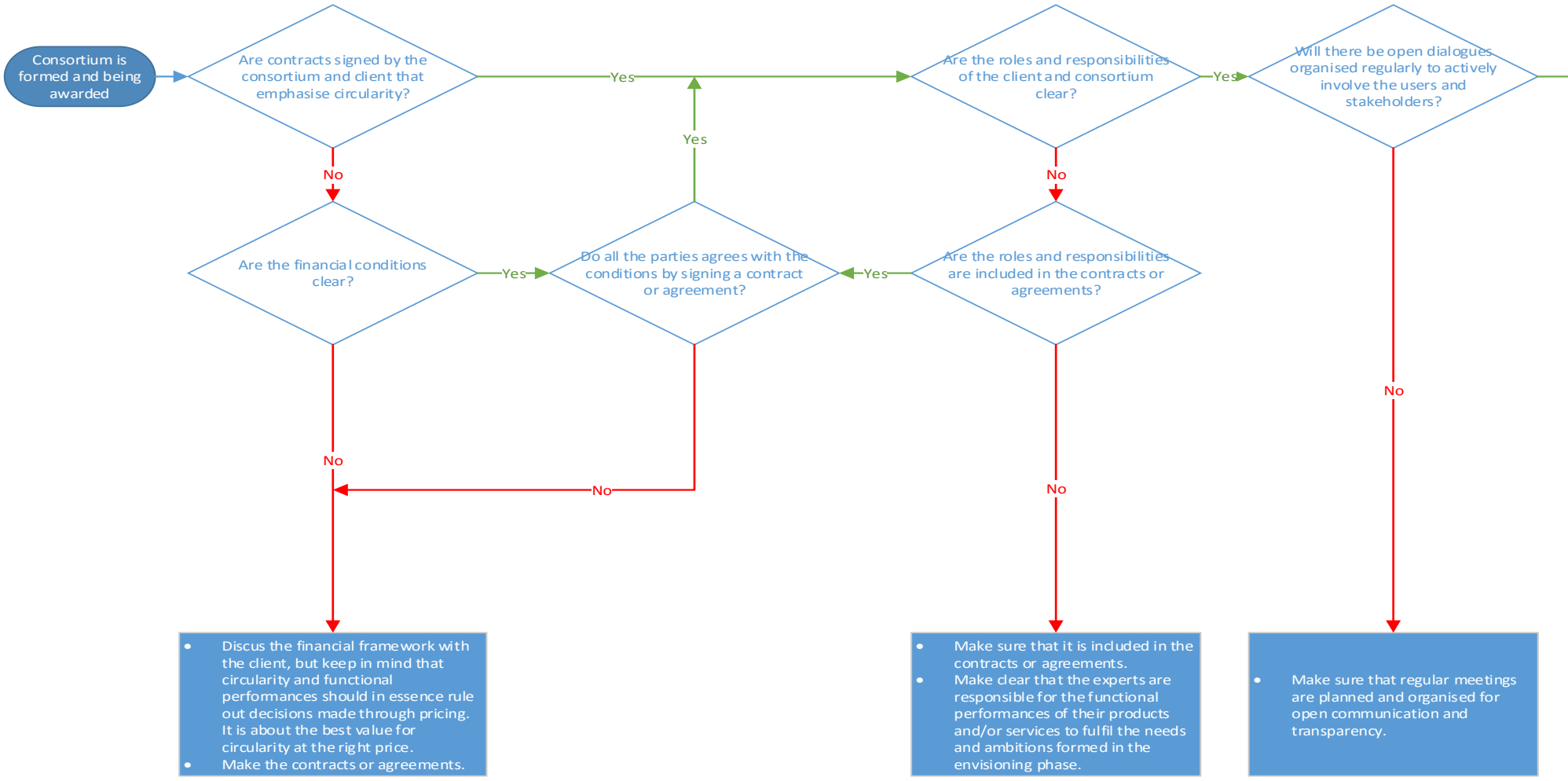


Envisioning Phase

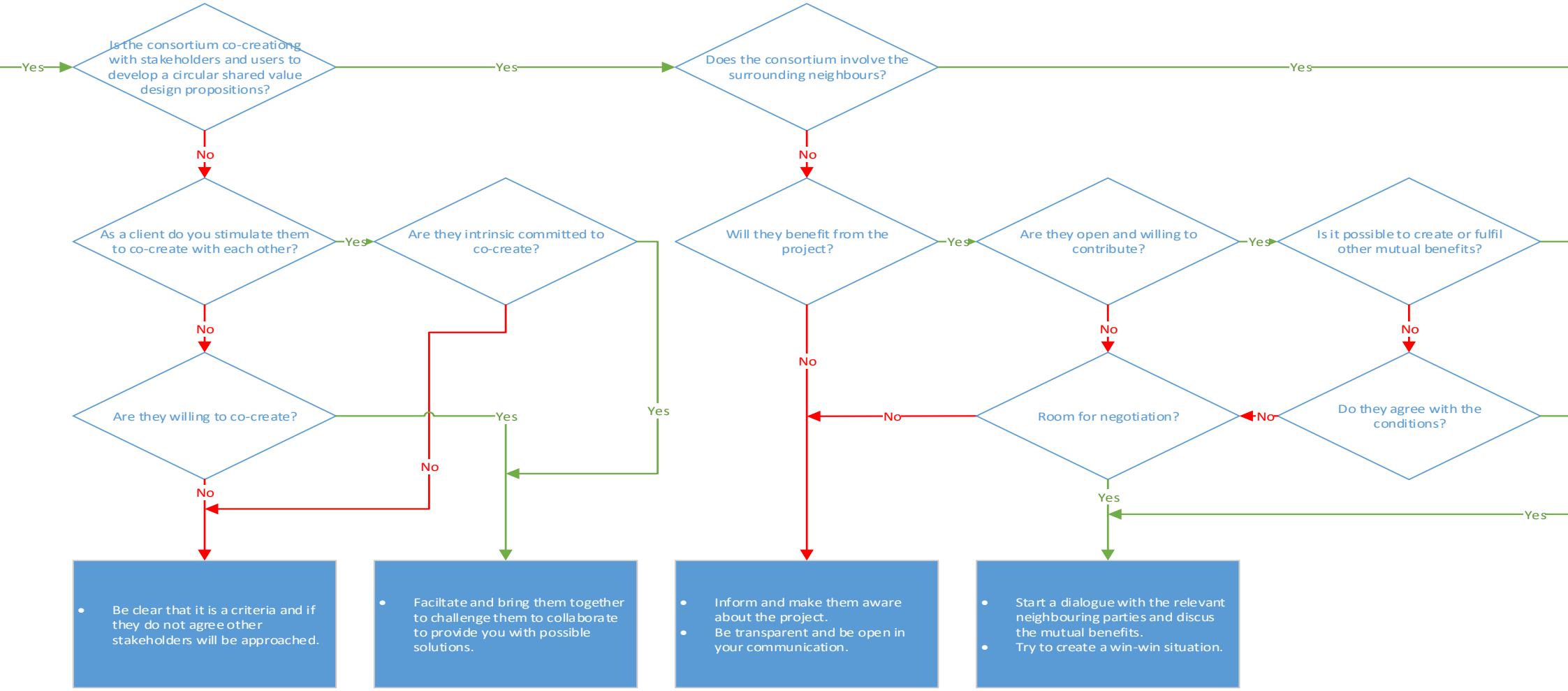


Appendix K-2: Co-Creation & Exploration Phase

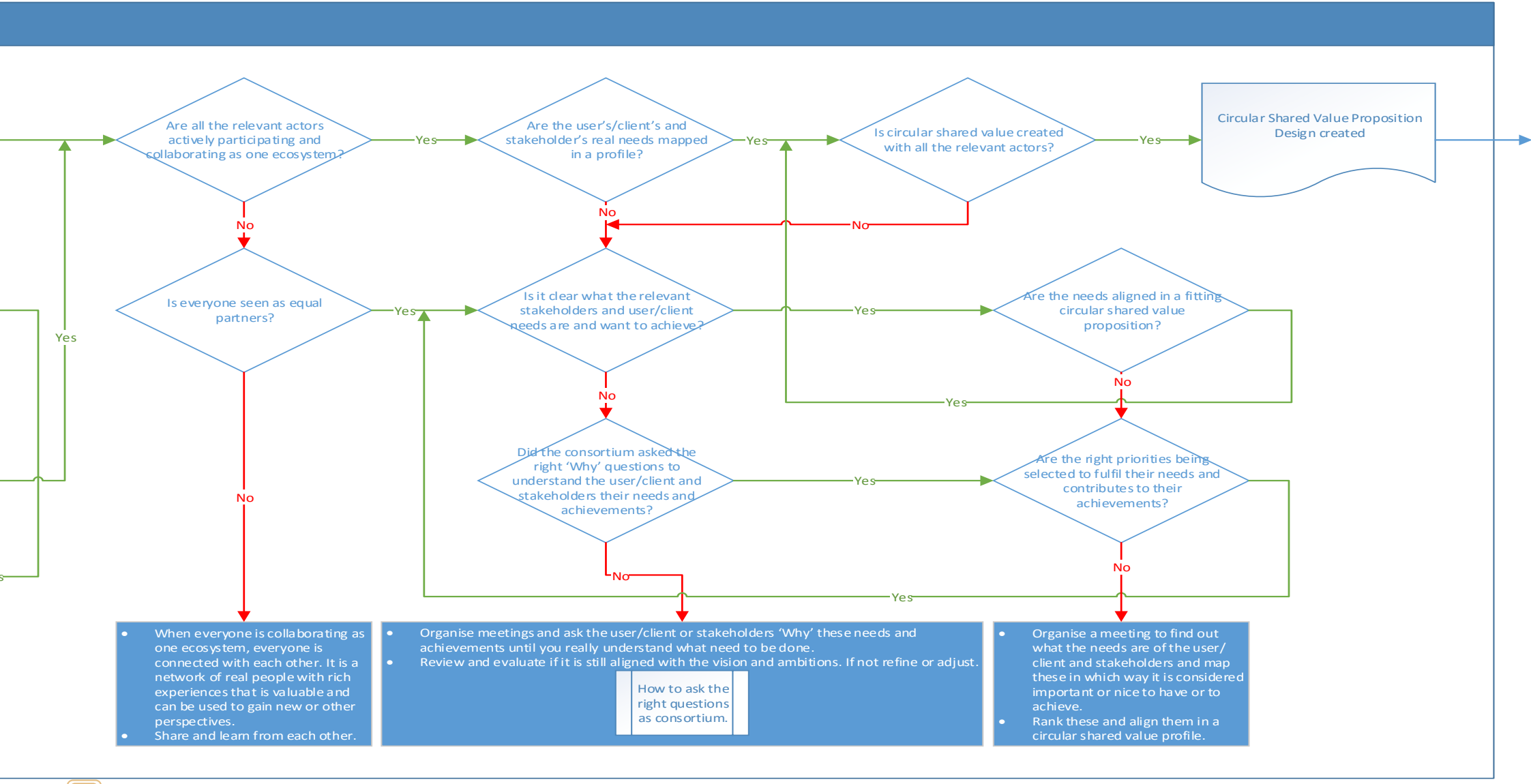
Degree of Actor Involvement



Co-Creation & Exploration Phase

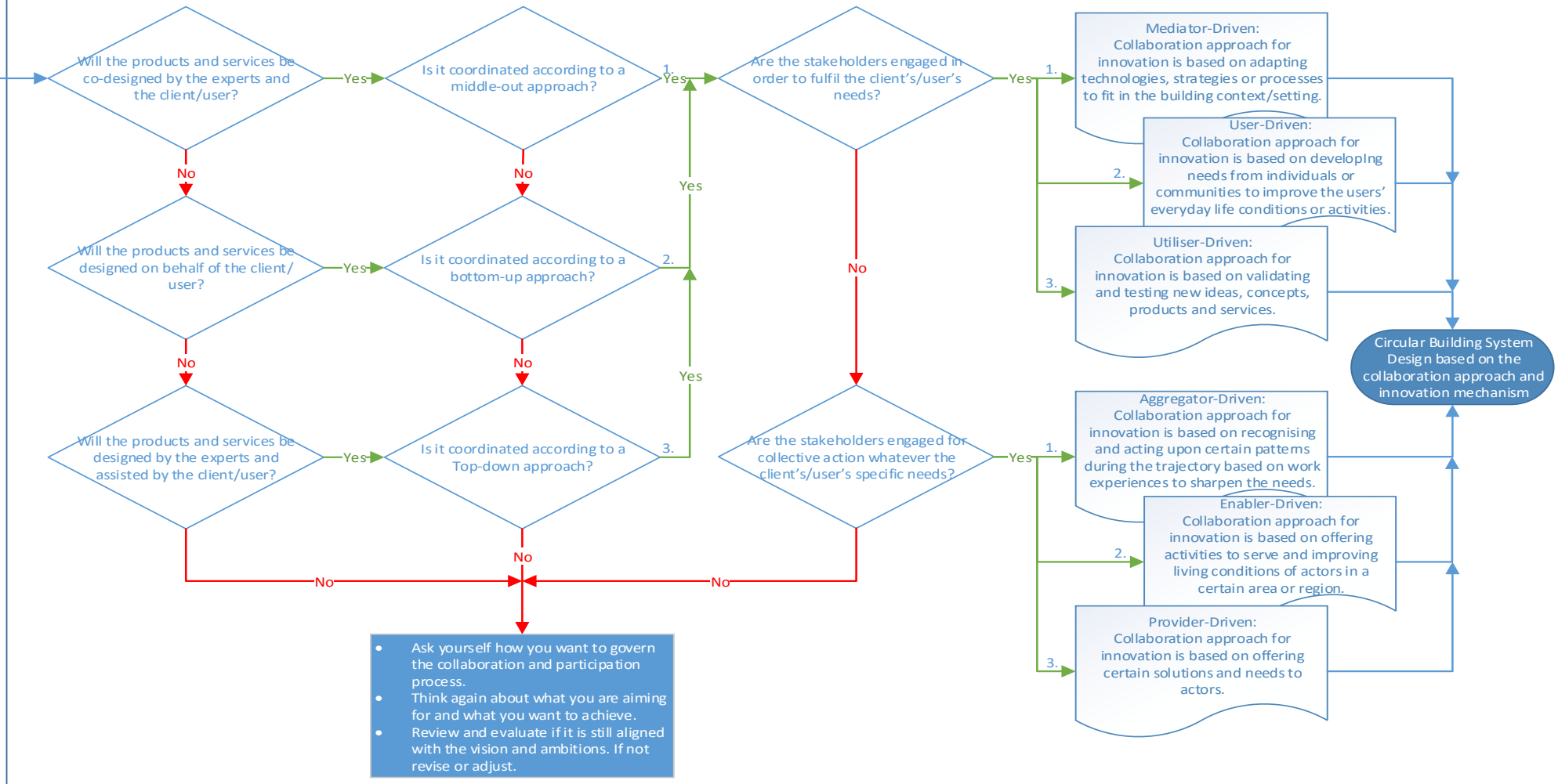


Co-Creation & Exploration Phase

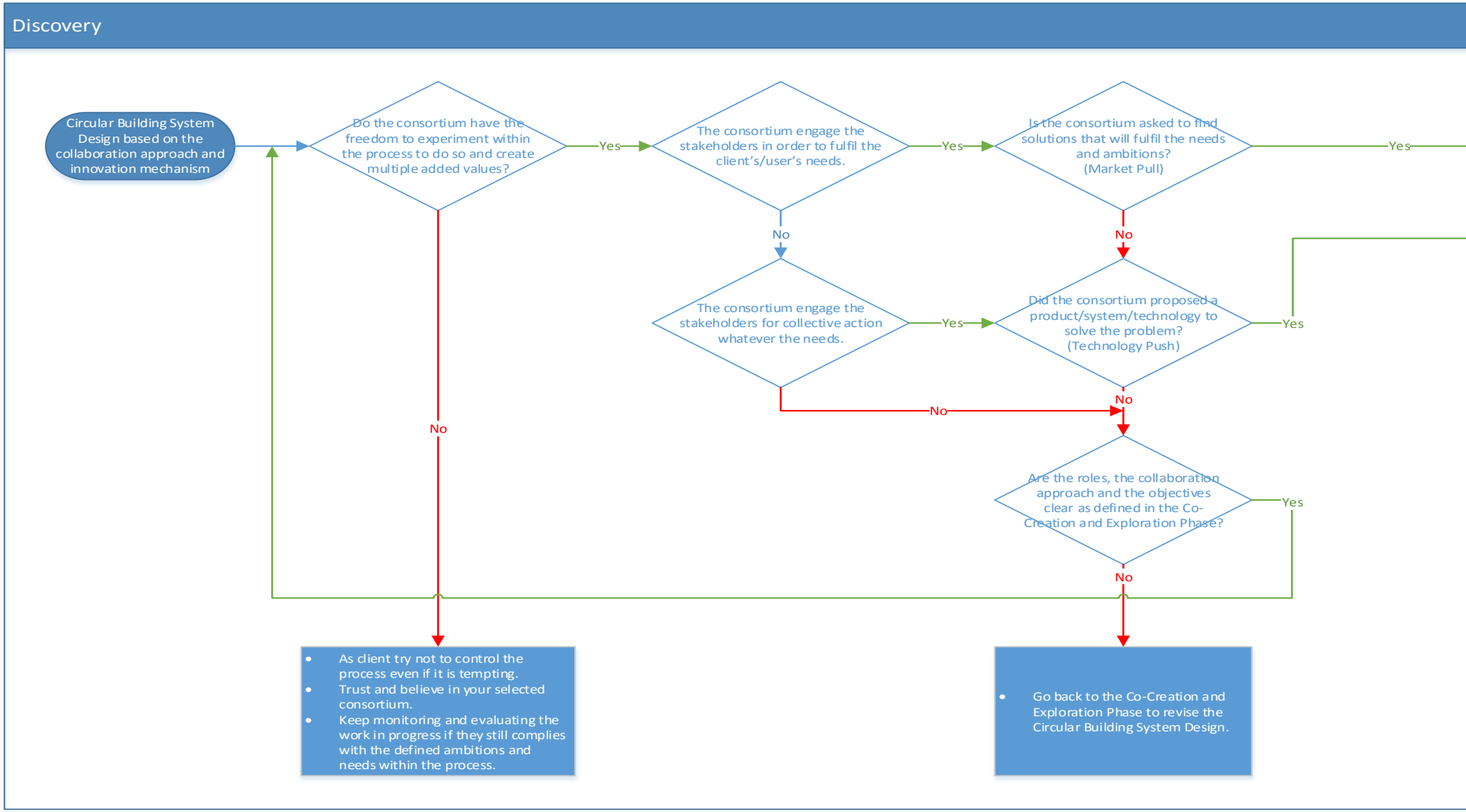


Co-Creation & Exploration Phase

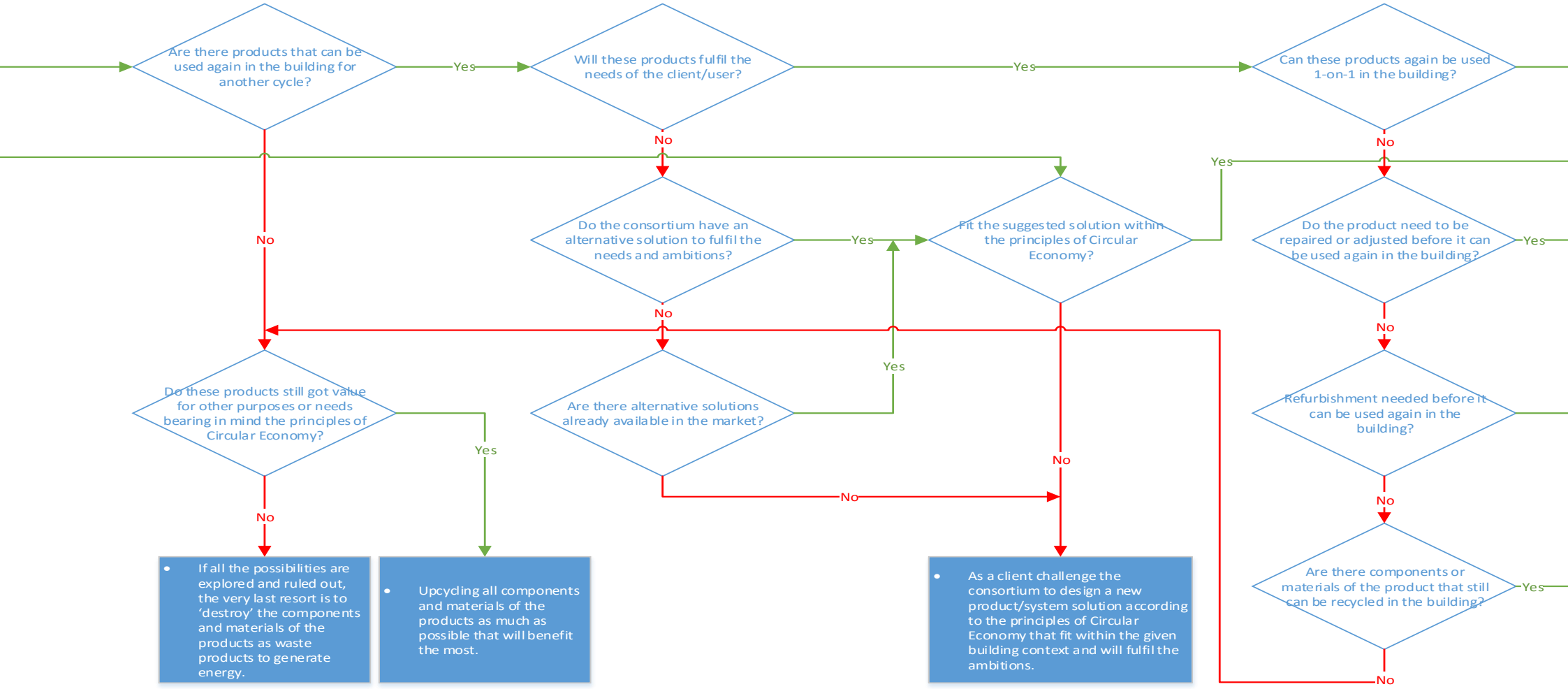
Collaboration Approach



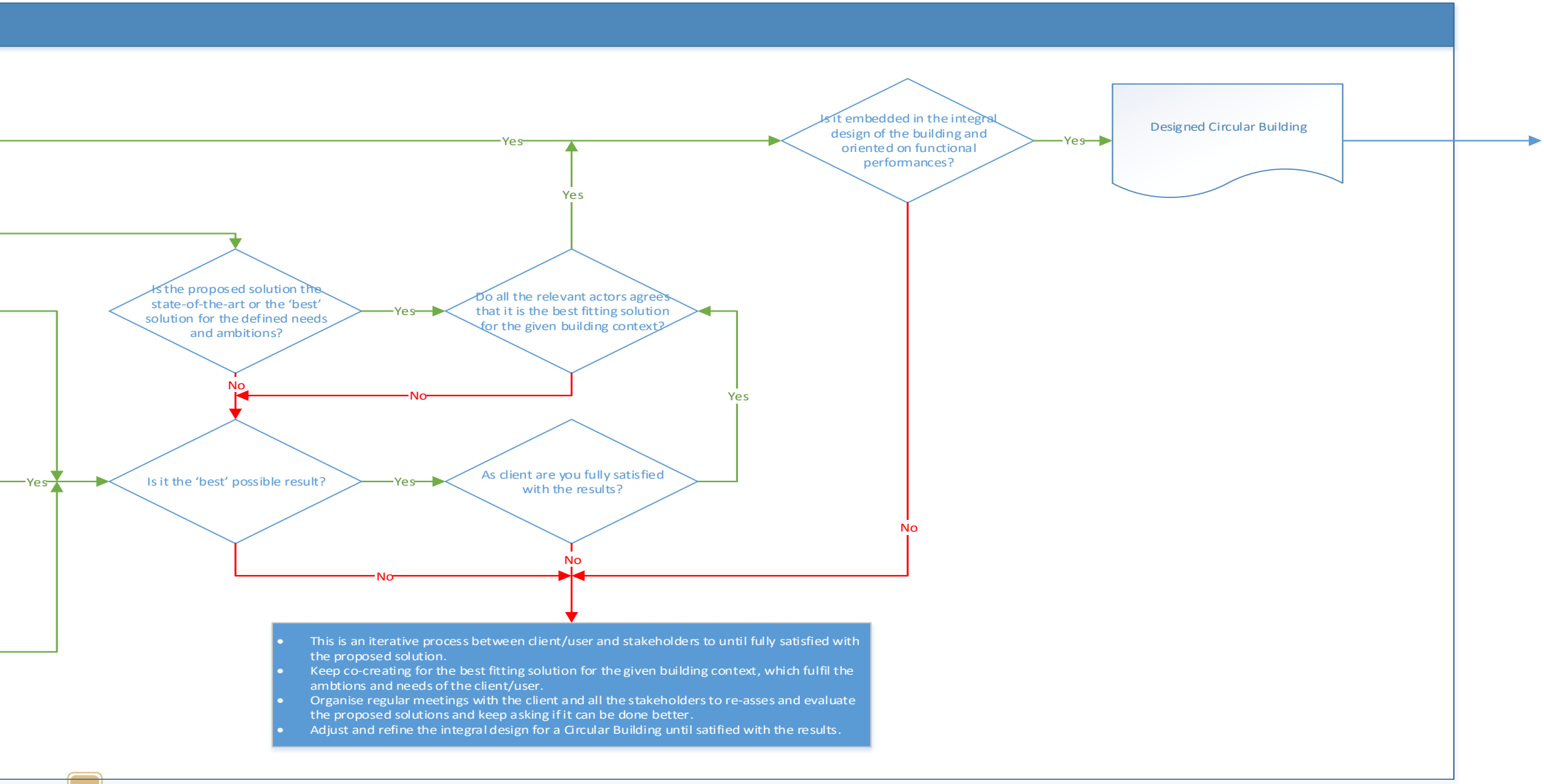
Appendix K-3: Experimentation Phase



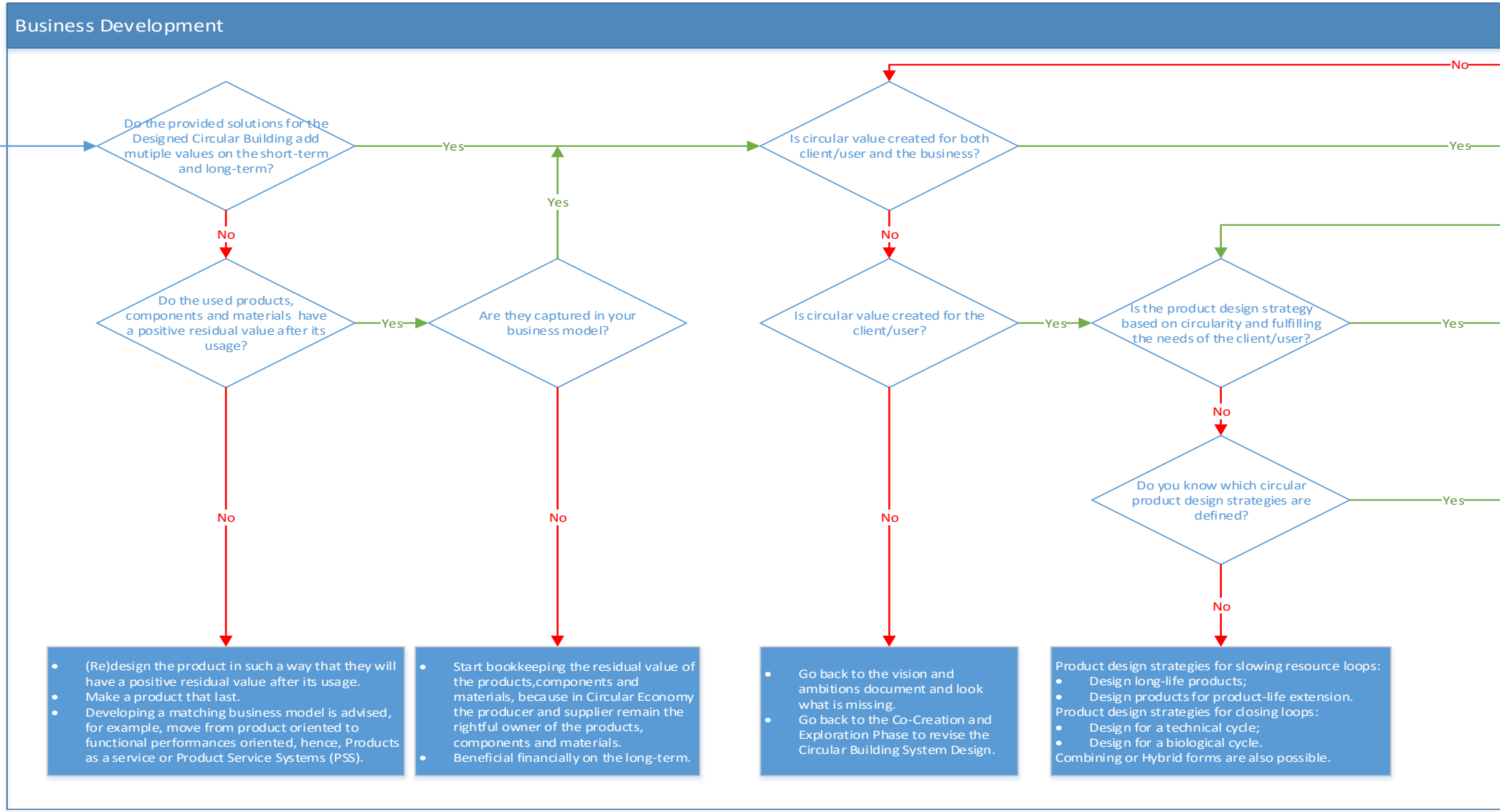
Experimentation Phase



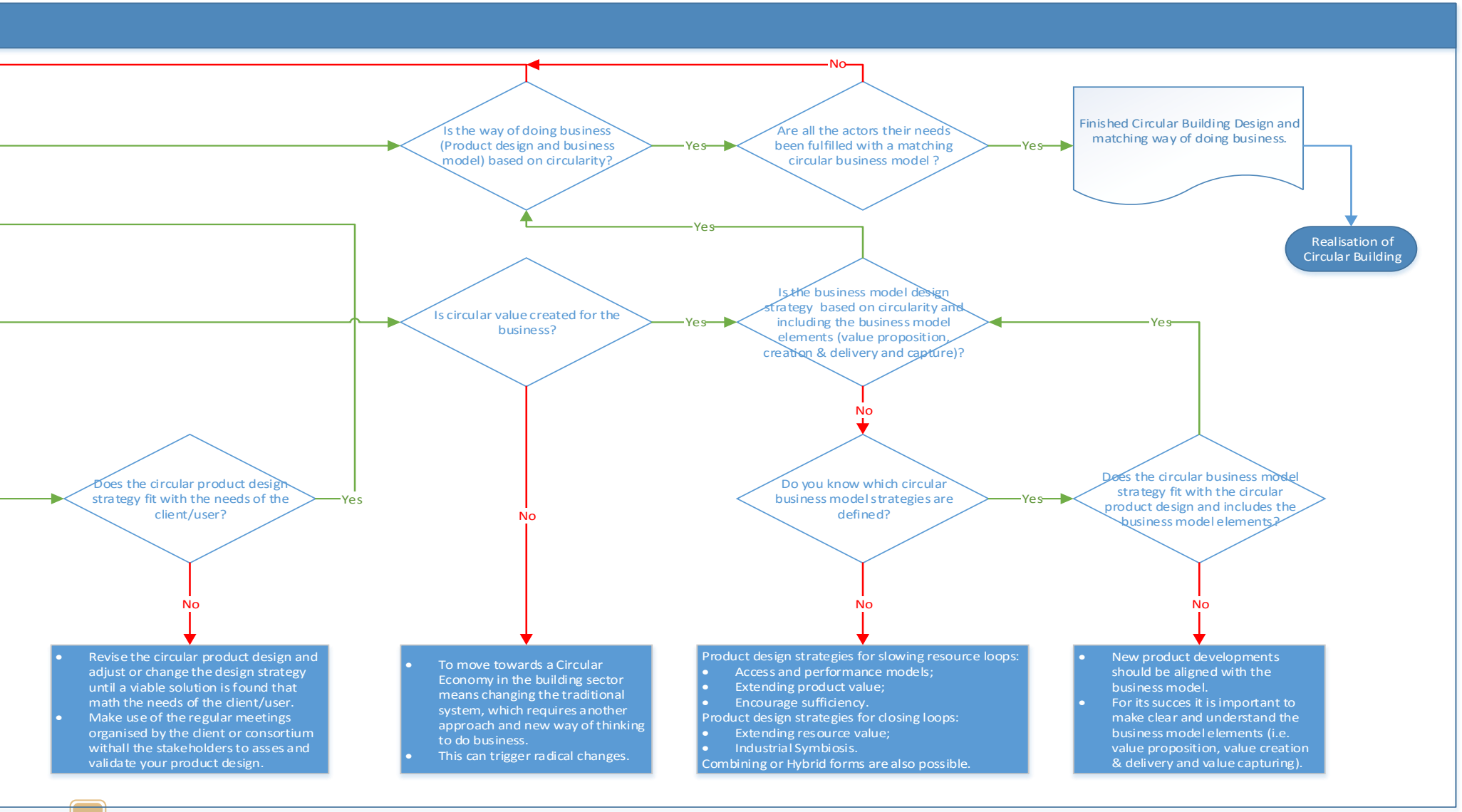
Experimentation Phase



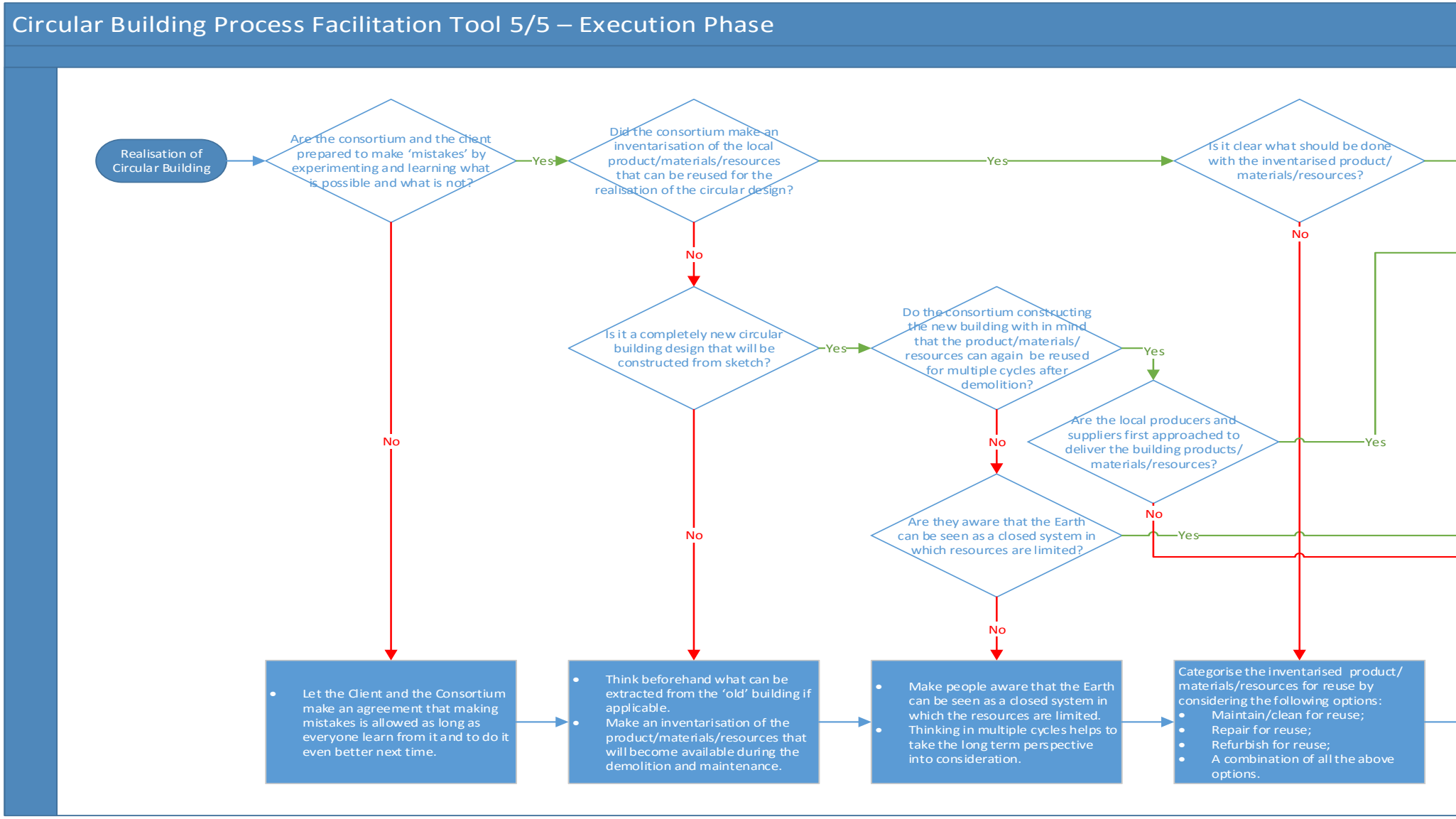
Experimentation Phase



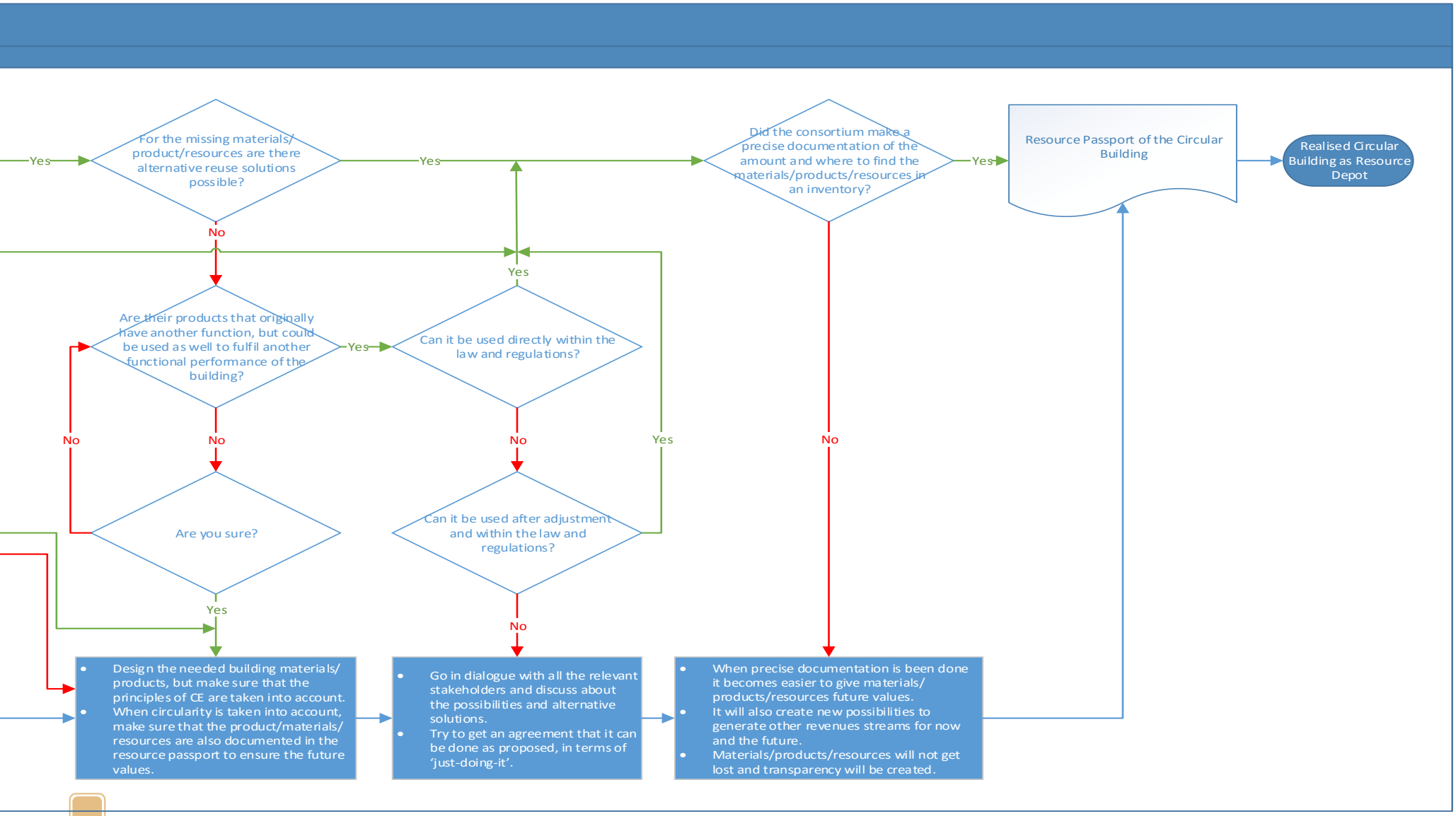
Experimentation Phase



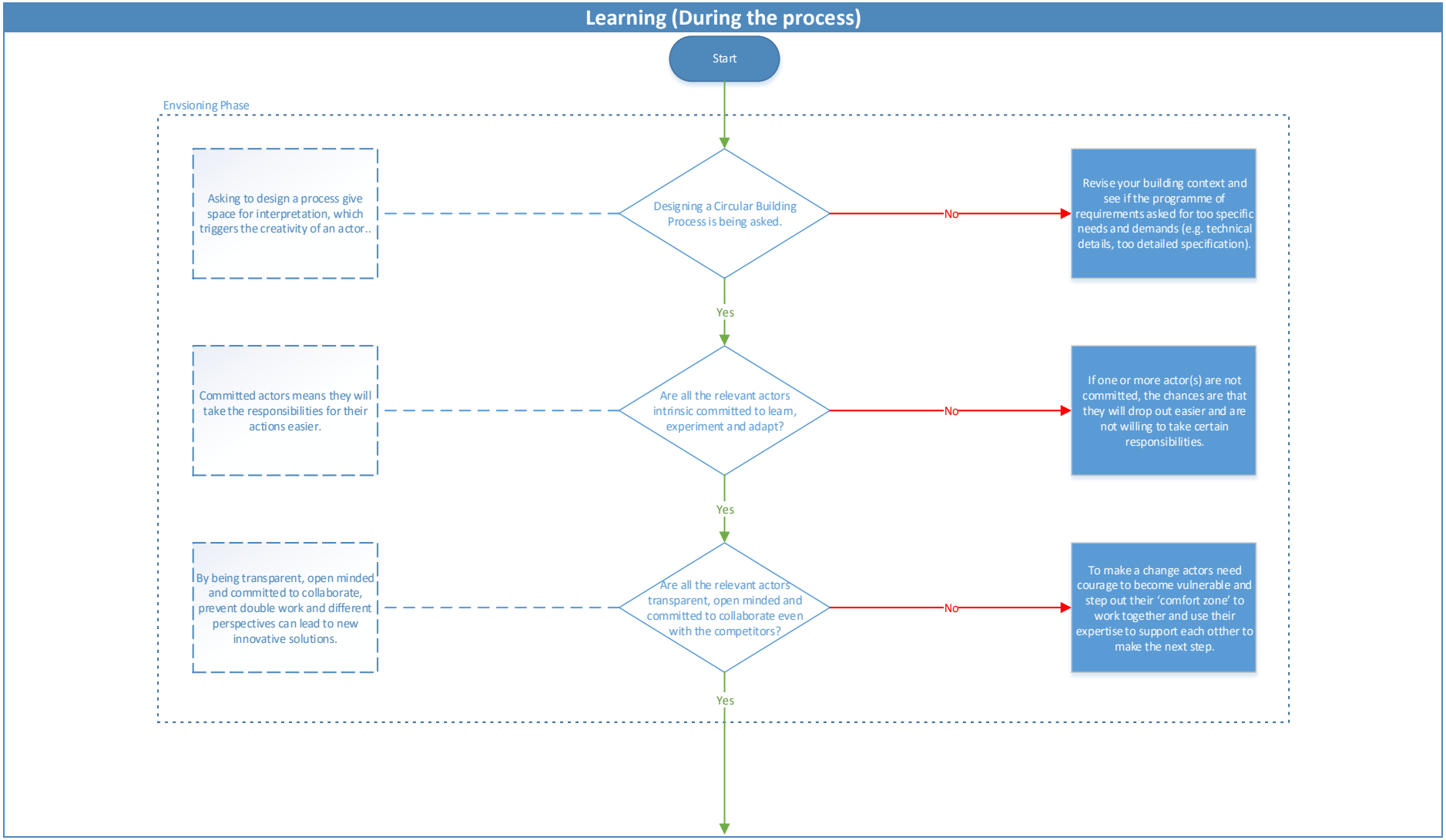
Appendix K-4: Execution Phase

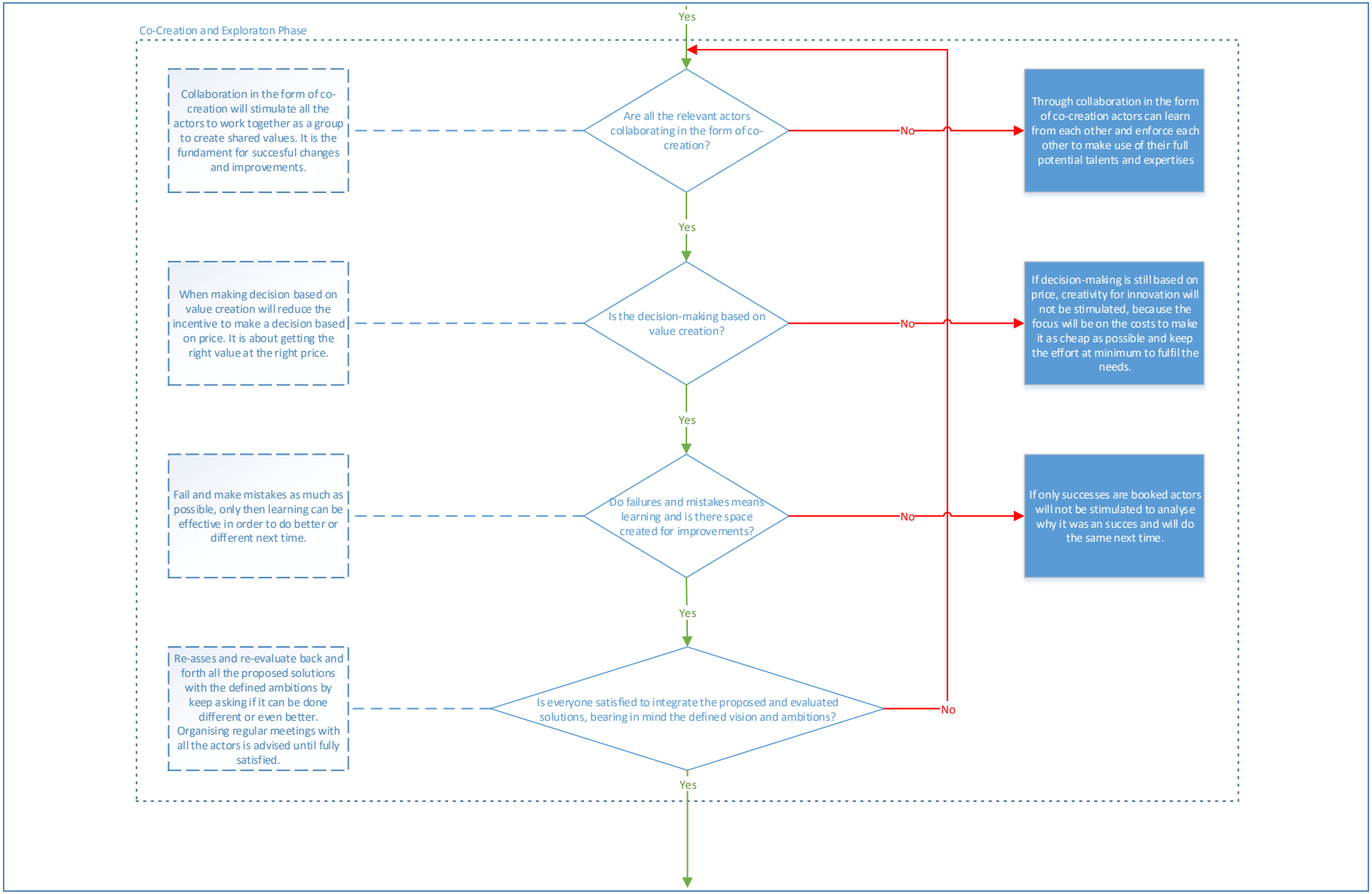


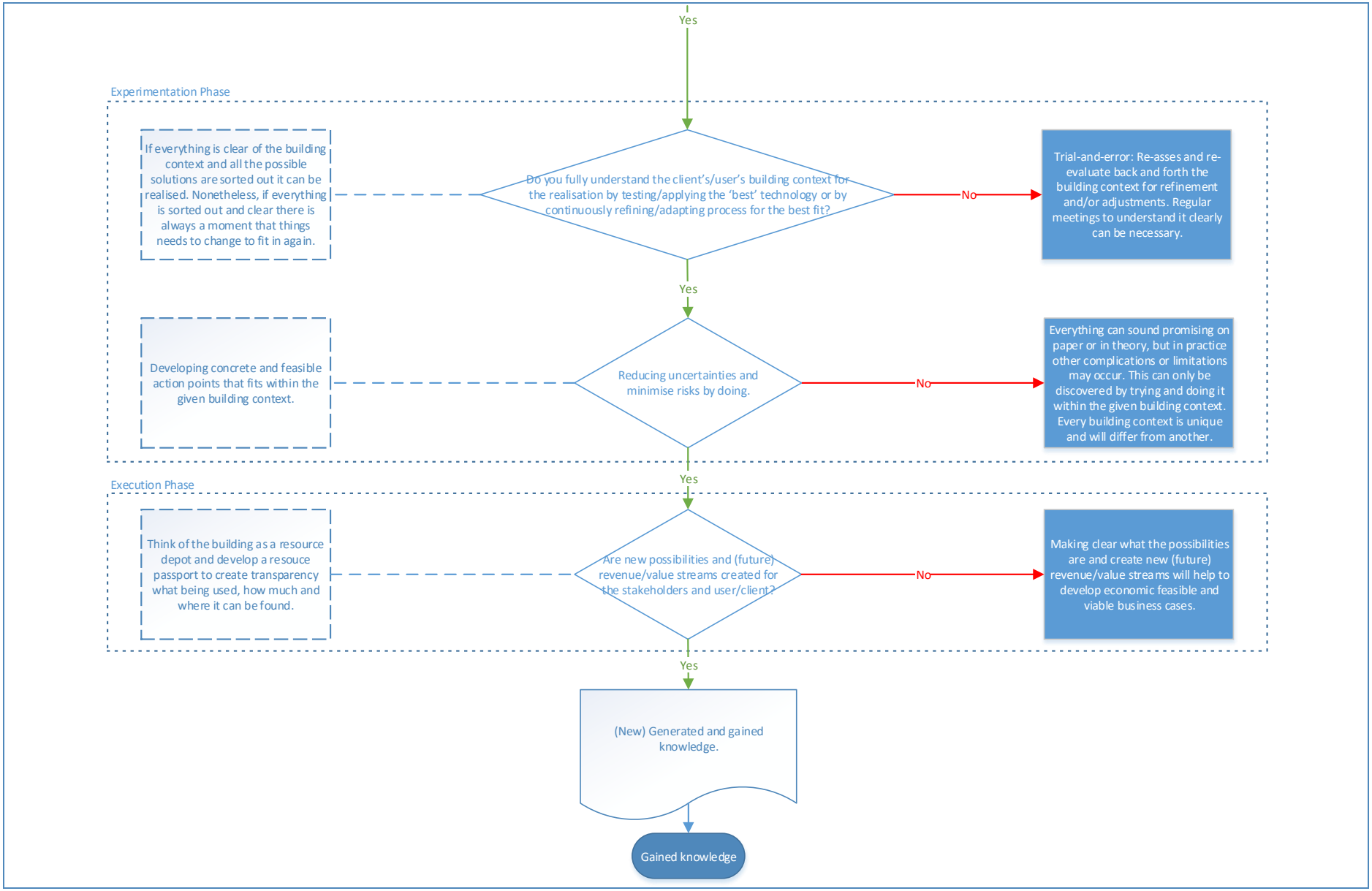
Execution Phase



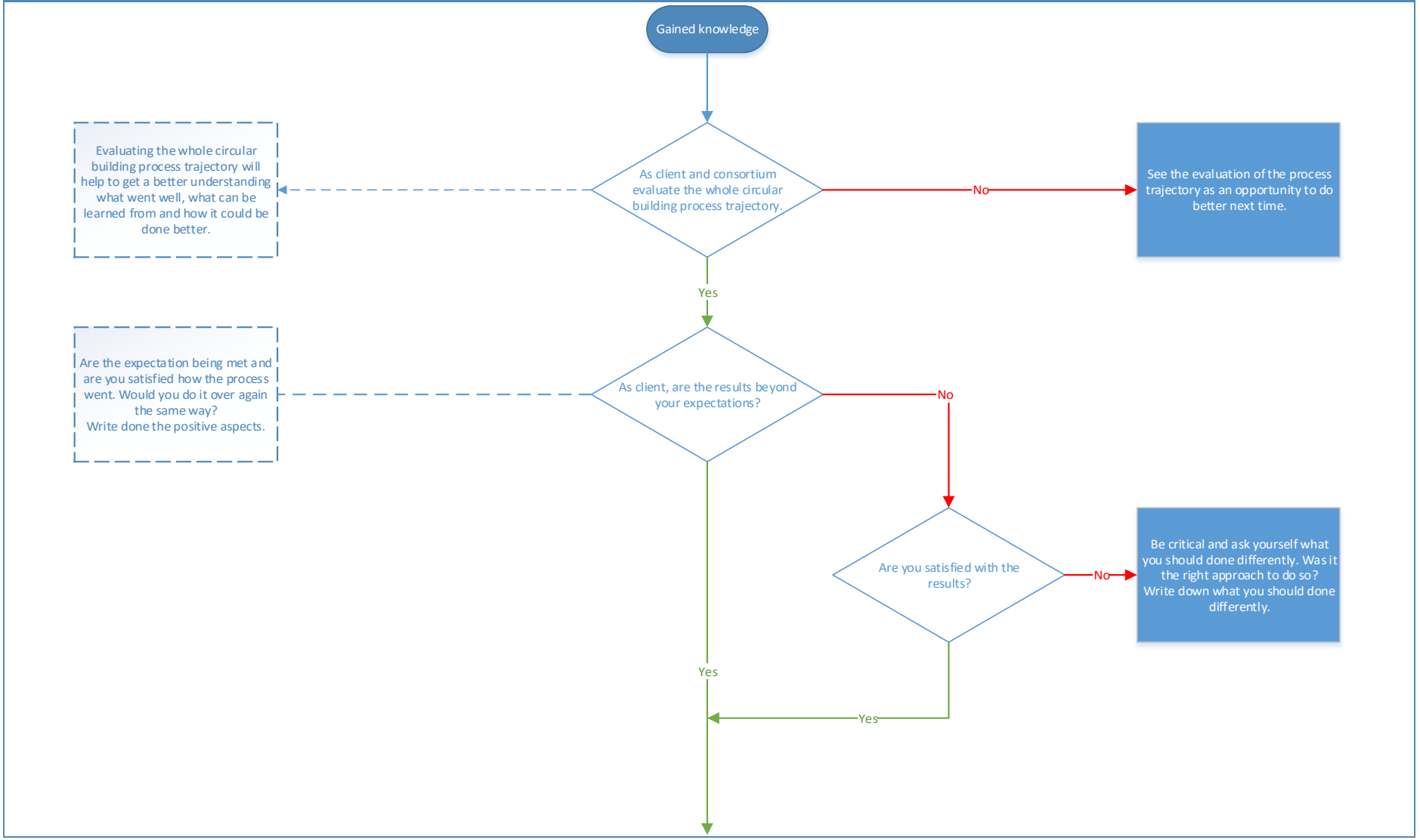
Appendix K-5: Monitoring & Evaluation

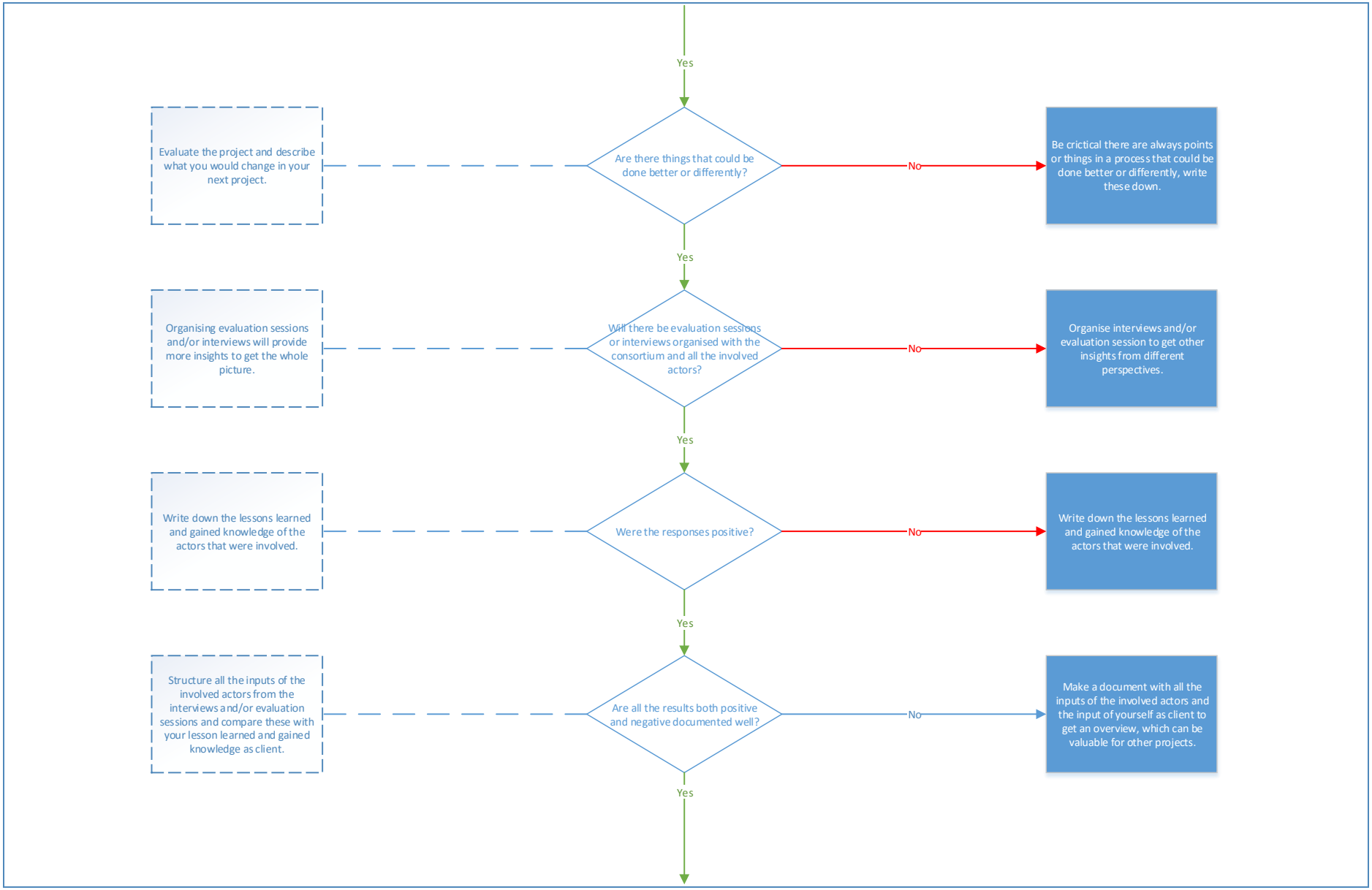


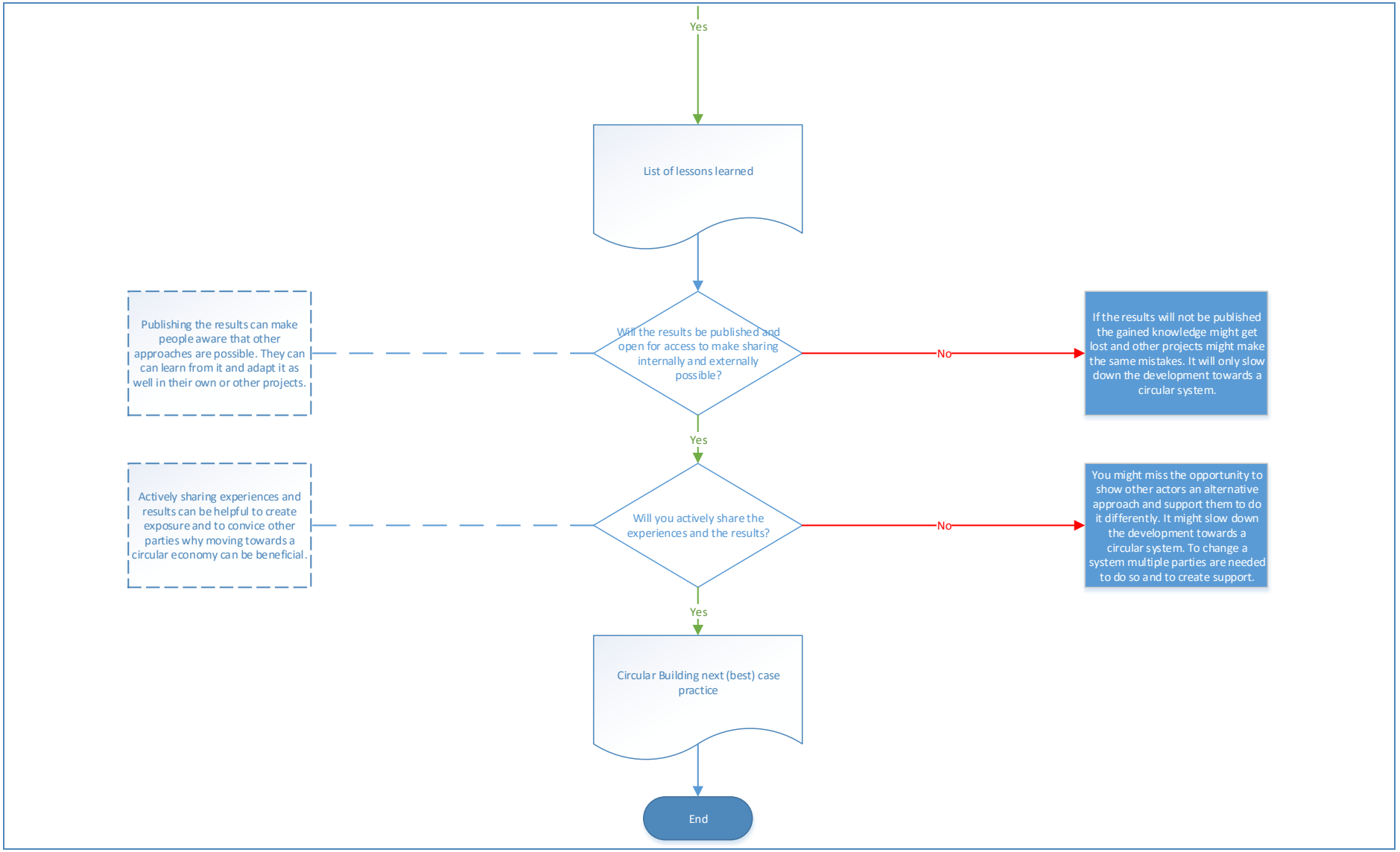

Co-Creation and Exploraton Phase
Yes
Collaboration in the form of co-creation will stimulate all the actors to work together as a group to create shared values. It is the fundament for succesful changes and improvements.
Are all the relevant actors collaborating in the form of co-creation?
No
Through collaboration in the form of co-creation actors can learn from each other and enforce each other to make use of their full potential talents and expertises
Yes
When making decision based on value creation will reduce the incentive to make a decision based on price. It is about getting the right value at the right price.
Is the decision-making based on value creation?
No
If decision-making is still based on price, creativity for innovation will not be stimulated, because the focus will be on the costs to make it as cheap as possible and keep the effort at minimum to fulfil the needs.
Yes
Fail and make mistakes as much as possible, only then learning can be effective in order to do better or different next time.
Do failures and mistakes means learning and is there space created for improvements?
No
If only successes are booked actors will not be stimulated to analyse why it was an succes and will do the same next time.
Yes
Re-asses and re-evaluate back and forth all the proposed solutions with the defined ambitions by keep asking if it can be done different or even better. Organising regular meetings with all the actors is advised until fully satisfied.
Is everyone satisfied to integrate the proposed and evaluated solutions, bearing in mind the defined vision and ambitions?
No
Yes


Yes
Experimentation Phase
If everything is clear of the building context and all the possible solutions are sorted out it can be realised. Nonetheless, if everything is sorted out and clear there is always a moment that things needs to change to fit in again.
Do you fully understand the client's/user's building context for the realisation by testing/applying the 'best' technology or by continuously refining/adapting process for the best fit?
No
Trial-and-error: Re-asses and re-evaluate back and forth the building context for refinement and/or adjustments. Regular meetings to understand it clearly can be necessary.
Yes
Developing concrete and feasible action points that fits within the given building context.
Reducing uncertainties and minimise risks by doing.
No
Everything can sound promising on paper or in theory, but in practice other complications or limitations may occur. This can only be discovered by trying and doing it within the given building context. Every building context is unique and will differ from another.
Yes
Execution Phase
Think of the building as a resource depot and develop a resouce passport to create transparency what being used, how much and where it can be found.
Are new possibilities and (future) revenue/value streams created for the stakeholders and user/client?
No
Making clear what the possibilities are and create new (future) revenue/value streams will help to develop economic feasible and viable business cases.
Yes
(New) Generated and gained knowledge.
Gained knowledge

Sharing Experiences (After realisation)




Yes
Evaluate the project and describe what you would change in your next project.
Are there things that could be done better or differently?
No
Be crictical there are always points or things in a process that could be done better or differently, write these down.
Yes
Organising evaluation sessions and/or interviews will provide more insights to get the whole picture.
Will there be evaluation sessions or interviews organised with the consortium and all the involved actors?
No
Organise interviews and/or evaluation session to get other insights from different perspectives.
Yes
Write down the lessons learned and gained knowledge of the actors that were involved.
Were the responses positive?
No
Write down the lessons learned and gained knowledge of the actors that were involved.
Yes
Structure all the inputs of the involved actors from the interviews and/or evaluation sessions and compare these with your lesson learned and gained knowledge as client.
Are all the results both positive and negative documented well?
No
Make a document with all the inputs of the involved actors and the input of yourself as client to get an overview, which can be valuable for other projects.
Yes


Yes
List of lessons learned
Publishing the results can make people aware that other approaches are possible. They can can learn from it and adapt it as well in their own or other projects.
Will the results be published and open for access to make sharing internally and externally possible?
No
If the results will not be published the gained knowledge might get lost and other projects might make the same mistakes. It will only slow down the development towards a circular system.
Yes
Actively sharing experiences and results can be helpful to create exposure and to convice other parties why moving towards a circular economy can be beneficial.
Will you actively share the experiences and the results?
No
You might miss the opportunity to show other actors an alternative approach and support them to do it differently. It might slow down the development towards a circular system. To change a system multiple parties are needed to do so and to create support.
Yes
Circular Building next (best) case practice
End

The coming decades, the building sector is facing challenges to reduce its impact as one of the major contributors on global problems, like resource depletion, pollution and climate change. The concept of Circular Economy, combined with aspects of Urban Living Labs, can help them to stimulate innovations and to develop businesses. To support the building sector facing those challenges, three circular building cases are analysed in the Dutch building sector. Based on these cases, this thesis proposed the Circular Building Process Facilitation Tool as guidance to initiate the transformation towards a circular building sector. By providing the clients with closed-ended questions, the tool promotes value based decision-making and the creation of a shared language for fulfilling mutual needs with all the stakeholders in order to develop circular buildings. For the clients, this tool is a way to embrace circularity as a journey of collaboration, co-creation, experimentation and learning to make a step towards a circular building sector.