Considerations for circularity in hotel buildings and operations

The opportunity for the hotelier to reduce their environmental impact in real estate

Katherine Beisler
June 27, 2019

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Cover photos: Hotel Jakarta, The Student Hotel, Conscious Hotel Westerpark, The QO Hotel

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"If we could change ourselves, the tendencies in the world would also change. As a man changes his own nature, so does the attitude of the world change towards him. ... We need not wait to see what others do."

- *Mahatma Gandhi*

Foreword

The research presented in this thesis is the culmination of the Management in the Built Environment master track within the faculty of architecture at the Delft University of Technology. This research is part of the Sustainable Urban Area Transformations graduation laboratory. The goal of this research was to explore how circularity can be implemented into hotel buildings and operations in order to reduce greenhouse gas emissions and as a part of sustainable urban development. As a result, the strategic and operational considerations of doing so are presented. The theoretical concepts and research techniques that have been used will be described in detail.

Acknowledgements

Conducting a research thesis is a long and uncertain process. I would like to thank me mentors Erwin Heurkens and Peter de Jong for staying with me as I adjusted my research proposal, and for their continuous support and flexibility throughout this process. Your time and input are greatly appreciated.

This research was conducted as part of the sustainable urban area transformations graduation lab. I would like to thank the other members of this group for their perspectives and keeping me on track. I would also like to thank my fellow MBE classmates for their support over the past two years.

I feel extremely fortunate to have found a partner in my graduation company, The Student Hotel, and my mentors Arjan van de Haar and Melike Çatalgöl who quickly and enthusiastically accepted my research proposal. Using the practical input of TSH has added a lot of value to my experience and to my research.

Finally, I would like to thank my friends and family near and far who have never doubted me. I am so grateful for you and your support and thank you for letting me explain to you the difference between round and circular. And to Jean-Louis for supporting me endlessly as we continue our journey together.

I hope you will find this report insightful, thank you for reading!

Katherine Beisler
June, 2019

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MSc Thesis
Katherine Beisler - katherinebeisler@gmail.com
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Delft University of Technology - MSc Architecture, Urbanism & Building Sciences
Master track: Management in the Built Environment
Graduation laboratory: Sustainable Urban Area Transformations
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Abstract

This research concludes on the strategic and operational considerations for implementing circularity in hotel buildings and operations. Sustainable urban area developments are increasingly led by private parties and facilitated by public parties. Hotels support the make-up of a sustainable mixed-use development while also trying to reduce their carbon emissions and meet the goals of the Paris Climate Agreement. To do so, circularity has been proposed as a solution. Through three case studies of pioneering hotels in Amsterdam and an additional test case in Delft, the considerations for implementing circularity in hotel buildings and operations have been discovered. Findings include considerations beyond the scope of real estate to include strategic business considerations such as position in the market, brand story, target market, community impact, environmental impact, regulations, partners as well as real estate and investment strategy. Operational considerations found were practical and included availability, durability, maintenance, reliability and aesthetics. These findings show that considerations extend beyond the scope of real estate and beyond the building level, leaving privately developed circular hotels to contribute to sustainable urban area developments.

Key Words: real estate development, hotel development, circularity, sustainability, circular hotels

Introduction

This research has been carried out within the Sustainable Urban Area Transformations Lab in the Faculty of Architecture at TU Delft. Sustainable urban areas are often mixed-use where the goal is to combine living, working and leisure together in one area in order that reduced environmental impact, allows businesses to establish and grow, increase job opportunities and offers a high-quality environment for the community (Reid, 2013). In these complex mixed-use urban developments, there are many actors, each working toward their own independent goals. In the Netherlands, the leading actor is shifting from the local governments to the private sector (Huismans & Vaan, 2011). This means that local governments are shifting to a facilitating role while development is left to private markets, leaving private-sector led urban area development to emerge as a potential strategy for developing sustainable areas (Regales, 2017 and Heurkens & Hobma, 2014).

To avoid the worst possible effects of climate change 195 countries signed the Paris Climate Agreement committing to reduce greenhouse gas emissions and limit global temperature rise (United Nations, 2015). The construction and building sector are the largest contributor to greenhouse gas emissions, with the use of buildings alone contributing 30-40% of total global greenhouse gas emissions (UNEP, 2011). A transition to a circular economy has been proposed as a solution to reduce greenhouse gas emissions and reverse the effects of climate change.

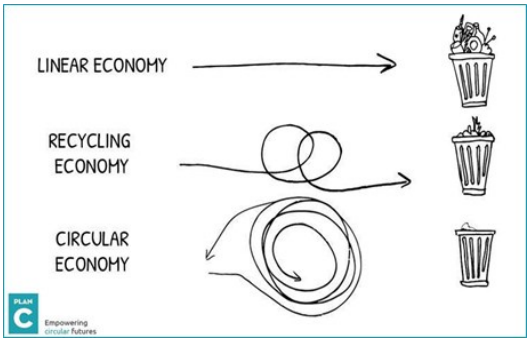

Figure 1: Linear economy vs circular economy (OVAM, 2019)

The hotel industry also realizes their ability to contribute to emissions reduction and has outlined a plan for decarbonization that highlights the gap between the impact of the hotel sector and the goals of the Paris Climate Agreement (International Tourism Partnership, 2017). Some hotels have begun to understand how they can implement circularity to reduce emissions and meet the goals of the Paris Climate Agreement (CREM, 2018).

Methodology

To answer the research question:

What are the strategic and operational considerations for implementing circularity in hotel buildings and operations?

A qualitative empirical research study was carried out. This included an exploratory literature review, exploratory interviews, a literature review, three case studies of pioneering hotels in Amsterdam with in-depth interviews, cross case synthesis and a test case within the graduation company. The last step of the research were two expert panels all together leading to conclusions and recommendations.

Literature review

The literature review provided many interpretations and definitions of the circular economy and circularity including the evolution of the concept which can be traced back to the 1970's (EMF, 2012). The concept of circularity has been suggested to reduce greenhouse gas emissions and reverse the effects of climate change. The goal of circularity is to close material loops in order to preserve environmental quality and extract fewer natural resources (Kirchherr et al, 2017). A wide variety of proposed solutions appear in literature, but some can be seen repetitively. A circular built environment should consider three resource flows: materials, energy and water (Ministry of IE I&M EA., 2016 and Kubbinga et al., 2018 and Van Odijk and Van Bovene, 2015 and Rau et al., 2016). This research defines a circular building as a building in which:

Materials are used from entirely reused or recycled or renewable sources
Energy comes from 100% renewable sources
Water leaves the building at the same purity level it came in

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Case studies

Three in-depth case studies were carried out with hotels in Amsterdam that are pioneering the implementation of circular initiatives. This included The QO Hotel, Hotel Jakarta and Conscious Hotel Westerpark. From the case studies a list of implemented circularity initiatives was gathered. This included initiatives in materials, energy and water categorized by building layer as proposed by Brand (1994) as a way to understand a building in life-span layers. These initiatives can be seen in table 1.

Table 1: Circularity initiatives from case studies

Building layer	Flow	Initiative
Stuff: 1-5years	Materials	Reuse fruit waste to make soap
		Give coffee grounds to mushroom farmers as fertilizer
		Greenhouse on roof - produces 4% of restaurant's food by weight and fish when possible
		Pre-cast concrete used a lot
		Minimize kitchen waste
		Service filtered tap water in reusable bottles - Madeblue
		Minimize construction waste
		Waste separation
		Circular bed and mattress concept with Auping
		Compost organic waste
	Energy	
	Water	
Space plan: 10 years	Materials	Circular carpeting (Interface) (Desso)
		Wood locally sourced in France and oil used to stain instead of lacquer
		Investing in long lasting materials - designed to be reused - break up into layers of components
		FSC certified wood/ Bamboo
		Minimize finishings
	Energy	
	Water	
Services: 25 years	Materials	
	Energy	Aquifer thermal energy storage
		Geothermal heating and cooling system into Ij river
		PV cells on the roof
		Solar water heater on roof
		PV cells on façade

		PV on a distance
		Building integrated photovoltaics
		Heat exchange on shower
		LED lighting
	Water	Greywater system from shower and sinks in guestrooms reused in the toilettes
		Low flow taps
		OZONE water used to clean rooms without chemicals
		Rainwater collection for atrium plant watering
		Sensors for tap flow
Skin: 50 years	Materials	
	Energy	Intelligent façade
		High insulation foil on double glazed windows
	Water	
Structure: 100 years	Materials	Building designed to be repurposed
		30% recycled concrete used
		Prefabricated modular rooms
		FSC certified wood/ bamboo
	Energy	High insolation on façade roof and floor
		Climate balcony: triple glazing to balcony and single glazing between balcony and outside
		Operable windows
		Greenhouse atrium as a thermal buffer: pre-heating in the winter leaf and water evaporation cooling in the summer
	Water	

Additionally, the motivations for implementing these initiatives were found to be intrinsic, regulatory and financial. The municipality of Amsterdam used their urban development management tools of regulation to incentivize Hotel Jakarta to be developed to high sustainability levels. Additionally, the municipality provided financial incentives to achieve a high-level building sustainability certification. Conscious Hotel and Hotel Jakarta were both motivated intrinsically towards their circularity initiatives.

The case hotels saw the advantages of implementing circularity to be certifications, gaining a competitive advantage and winning awards. They saw the challenges as unclear benefits, how to improve upon what they had already done, regulations running behind their ambitions, finding suitable partners, guest behavior, high IT costs and initial financial investments.

Test case

To further understand the difference between a traditional building and one that had implemented circularity a test case was used. The test case was The Student Hotel in Delft, currently under development by the graduation company, The Student Hotel. One initiative from each of the categories of circularity in buildings was tested:

Table 2: Circularity initiatives for use in test case

Resource flow	Circularity initiative	Goal: gather strategic and operational considerations for implementing:
Materials	Flooring options	Circular flooring
Energy	Energy neutral building	EPC=0
Water	Rainwater collection and reuse	In toilettes and for plant watering

It can be concluded that the flooring options tested were not truly circular because of their inability to be recycled or reused without being degraded. Implementing an energy neutral building or rainwater collection and reuse should be considered from the beginning of development and are difficult or impossible to include later on. These measures should be included in the original design of a new hotel to

be most physically and financially feasible. Furthermore, support from public parties like the municipality can encourage more projects to implement these initiatives.

Two expert panels discussed the strategic and operational advantages and challenges for implementing a circular initiative over a standard one. Their discussion was much broader than just real estate but focused heavily strategic opportunities such as brand story, target market, and position in the market. Operational challenges are practical such as maintenance and durability of a circular product.

Findings

Based on the outcomes of this research it can be concluded that implementing circularity in hotel buildings and operations has a far greater impact than on the building itself. The hotels studied in this research are public urban hubs and have the potential to make an impact on the community and their guests. This makes the considerations for implementing circularity much broader than the costs or savings for implementation but on many strategic and operational factors. The strategic considerations can be seen in figure 2, operational considerations can be seen in figure 3.

Figure 2: Findings - strategic considerations for implementing circularity in hotel buildings and operations

Figure 3: Findings - operational considerations for implementing circularity in hotel buildings and operations

Recommendations

Following the development cycle provided by The Student Hotel recommendations for considering and implementing circularity are provided. An overview of all recommendations along the development cycle can be seen in figure 4.

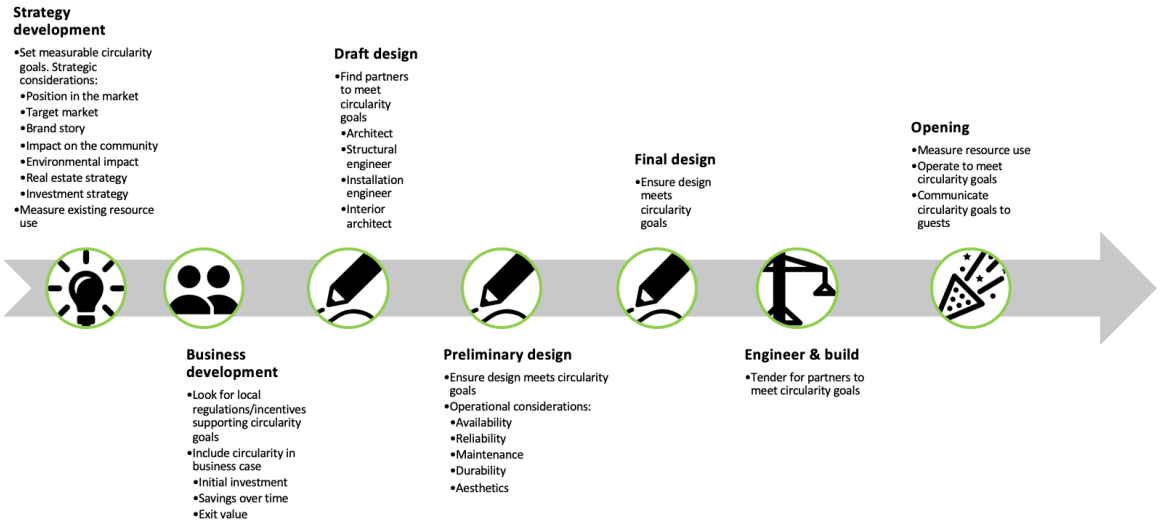

Figure 4: Recommendations for graduation company along development cycle

Recommendations for the real estate industry are to define and measure circularity in the built environment. Currently the definition of circularity is vague and debated in theory making it difficult for

practitioners to work agree on a goal. To differentiate circularity from sustainability it should be defined, therefore providing something to measure and work towards. The threat of not defining circularity is that it becomes overused and associated with initiatives that are not reducing the environmental impact, as seen in this research.

Hotels are already an important component to mixed-use development. By providing public space and reaching many people every day from guests to visitors they represent the perfect platform to communicate and represent a sustainable area transformation. Especially with the increase in private-sector led development, hotel developers have become crucial to the puzzle of a complex sustainable mixed-use area.

Policy recommendations include using the tools available to public parties as urban development managers. This means further regulating and incentivizing circularity in urban area development including hotel development. The City of Amsterdam has uniquely done this by requiring a certain sustainability level from all new hotel developments.

This research encountered questions for further research. They are:

- How to influence user behaviors
- How to measure circularity
- What adds value to buildings over time
- Relationship between adaptability and exit value
- Investors willingness to pay for sustainable buildings

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Introduction

The threats of climate change have encouraged the real estate industry to move to adopt sustainable practices. This has led to the development and growing prevalence of LEED and BREEAM certificates. The hospitality industry has also identified its contribution to climate change and need to adopt more sustainable practices. Following the signing of the Paris Climate Agreement all signatory countries needed to meet the requirements for emissions reduction set by the agreement. The Netherlands released their vision for "A Circular Economy in the Netherlands by 2050" which included goals for the construction industry.

To meet these goals, and join the circularity trend, many companies have made claims to be circular. This includes circular buildings, circular hotels and circular business models. But what is circularity? What is meant by a circular built environment? And a circular hotel?

This graduation research aims to inform hotel owners and real estate managers about circularity, and how it can be implemented into their real estate. Conclusions are made about the strategic and operational considerations of implementing circularity into hotel buildings and operations. Also, recommendations are made for the industry and policy.

To do so, a research design is made to provide a framework for this thesis. This consists of three parts: concepts, practice, and conclusions.

Readers Guide

In part 1: Concepts, the structure and background for the research are presented. The research proposal is presented in chapter 1, the methodology in chapter 2, and the theoretical background in chapter 3.

In part 2: Practice the practical implications of circularity in hotel buildings and operations will be presented. Chapter 4 includes three in-depth case studies of hotels in Amsterdam that have implemented circularity initiatives. Chapter 5 aggregates the findings from case studies as well as the lessons learned. The findings are tested and further investigated with the graduation company in chapter 6 and 7.

This research concludes with Part 3: Conclusions. This section includes conclusions to the research questions and a discussion over the research in chapter 9. Chapter 10 provides recommendations for the graduation company, practice and policy. Finally, in Chapter 11 a reflection on of the research process is provided.

A list of references is included at the end of this thesis the annexes provide additional information.

Part 1 – Concepts

Proposal, methodology and theory

1 Research proposal

1.1 Introduction

This chapter is the introduction to the research proposal. In this chapter the research topic and relevance are included as well as the utilization potential. The relevance of the topic is explained from multiple angles. The aim of the research is provided in the conclusion of this chapter.

1.2 Research topic

In a global effort to mitigate climate change the Paris Climate Agreement called for a reduction in greenhouse gas emissions. Greenhouse gas emissions are directly linked to the average global temperature, which has steadily risen since the industrial revolution. Carbon dioxide is the most abundant greenhouse gas, accounting for 2/3 of all greenhouse gas emissions (United Nations, n.d.). 195 countries have signed on to the Paris Climate Agreement and developed their own strategies for reaching these goals (United Nations, 2015). The construction and building sector are the largest contributor to greenhouse gas emissions, with the use of buildings alone contributing 30-40% of total global greenhouse gas emissions (UNEP, 2011).

A transition to a circular economy has been proposed as a solution to reduce greenhouse gas emissions and reverse the effects of climate change. One of the challenges of the circular economy is that its definition is still vague and means different things to different people (Kirchherr et al., 2017). The concept of circularity aims to use les raw materials compared to the traditional way of making, using and disposing of products. Since the industrial revolution products have mostly been made following a linear economy, focused on a "take, make, waste" model. This circular regenerative model produces less emissions and waste by giving waste an identity and repurposing it for a new use, see figure 1.1 (Rau et, el, 2016).

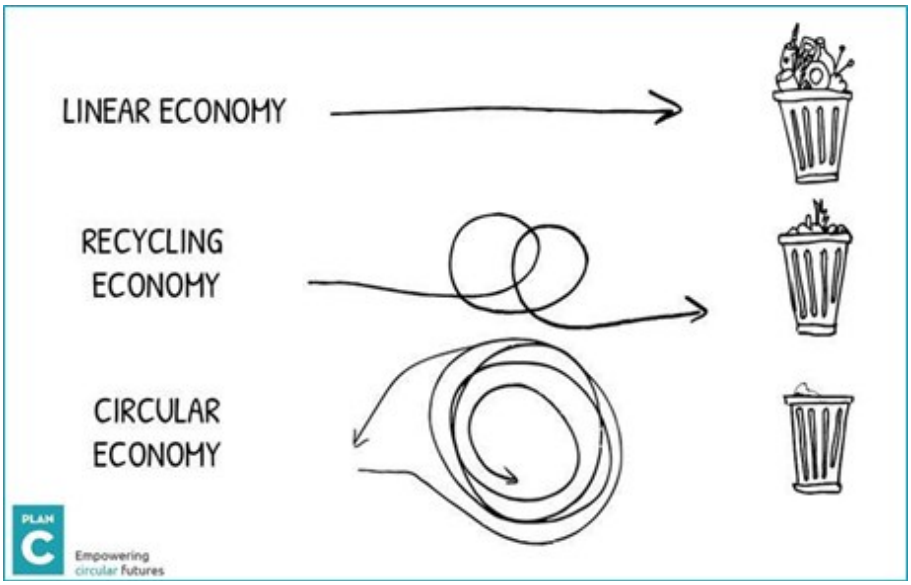


Figure 1.1: Linear economy vs circular economy (OVAM, 2019)

The real estate sector, being highly resource intensive (UNEP, 2011) has a great potential to contribute to the new circular economy and reduce global emissions. As a part of the vision for "A Circle Economy in the Netherlands by 2050" the Dutch government has identified the construction industry as one of the

most environmentally impactful and laid out a strategy for a circular built environment. Additionally, the Dutch Green Building Council and other circularity researchers have presented a framework for a circular built environment. These frameworks have identified the most environmentally impactful systems in the built environment as materials, energy and water along with suggested circularity initiatives to reduce the environmental impact of the built environment (Kubbinga et al., 2018) (Van Odijk and Van Bovene, 2015).

The hotel industry also realizes their ability to contribute to emissions reduction and has outlined a plan for decarbonization that highlights the gap between the impact of the hotel sector and the goals of the Paris Climate Agreement (International Tourism Partnership, 2017). The International Tourism Partnership aims to fill the gap through emission reductions. More specifically, a group of hotels in Amsterdam have collectively accepted their responsibility for emissions reduction and chosen to work together to brainstorm and implement circularity initiatives (CREM, 2018). In this research the opportunities for circularity in hotel buildings and operations will be explored. Existing case projects will be presented and select initiatives will be tested for strategic and operational considerations. This research will conclude by providing recommendations to TSH, the graduation company, as well as others, on what to consider when implementing circularity initiatives.

1.3 Research relevance

Scientific relevance

The United Nations Environment Program has identified the high levels in which real estate currently uses resources and contributes to greenhouse gas emissions (UNEP, 2011). Strategies for the real estate sector to implement circularity have been identified by Kubbinga et al. (2018). These strategies include looking at materials, energy, water, biodiversity and ecosystems, human culture and society, health and wellbeing and multiple forms of value and will be explained further in section 2.3.4. They have even identified the ways in which this could be measured for materials, energy and water but not for the other strategies. This pointes to one gap in literature between the theoretical implementation of circularity in real estate and what this means in practice.

In addition, The International Tourism Partnership (ITP) has issued a report on how hotels can decarbonize to reduce emissions and help reach the goals of the Paris Climate Agreement. The report points out the gap between the impact of the sector and the goals of the Paris Climate Agreement. In an effort to fill this gap the report calls for hotels to become more efficient, more electrified and more renewable (International Tourism Partnership, 2017). The ITP report does not suggest the implementation of circularity to fill the gap and little other research exists on this topic.

Societal relevance

In 2016 the Dutch Government launched a program to develop a circular economy in the Netherlands by 2050. Included in this program is the objective to reach a 50% reduction in primary raw materials by 2030. While the government took responsibility for spearheading the plan, the program calls on the support of citizens, industries and local governments to get involved with the goal of making the Netherlands less dependent on importing raw materials and creating a healthier, cleaner environment. (Ministry of IE I&M EA., 2016).

This transition to a circular future is aimed at curbing climate change which has a detrimental effect to society. Effects of climate change include an increase of extreme weather patterns, food scarcity, loss of biodiversity and habitat and an increase in poverty (United Nations, 2015). Every sector should

investigate ways to work together to avoid the effects of climate change. Embracing circularity is a possibility for real estate to reduce its impact.

Sectoral relevance

Real estate has an important role to play in the reduction of emissions through the ability to participate in a circular economy. Through the transition from linear real estate models to circular ones the opportunity exists to improve the resource efficiency of many systems. The systems approach of circularity also includes an investigation into the larger area development as a whole. This includes an investigation into how the built environment can work together on an urban or city scale as a system of interconnected buildings supporting each other in the effort to close resource loops.

This research is also relevant for the hospitality sector which has stated its interested in decarbonizing and contributing to the Paris Climate Agreement's goals. While not yet implemented on an industry wide level, hotels have begun organizing on their own. The Circular Hotel Leaders Group in Amsterdam have begun investigating how they can work together to benefit from circularity.

Relevance for graduation company

This research is being carried out in collaboration with The Student Hotel (TSH). TSH is committed to reducing their environmental impact with the goal of inspiring guests to do the same. TSH is already working on circularity initiatives and understands their position as a growing real estate developer but also as having a behavioral impact on young students.

To structure their impact initiatives TSH has developed a 6-pillar framework, seen in figure 1.2. The framework includes "we green our buildings", "we source locally and responsibly" and" we minimize our footprint". This research will further develop these three pillars by using TSH as a test case for circularity initiatives. This research will help TSH gain an understanding of circularity initiatives already in practice and will specifically identify initiatives that are beneficial to the TSH strategy and brand as a real estate developer and as a hotel.

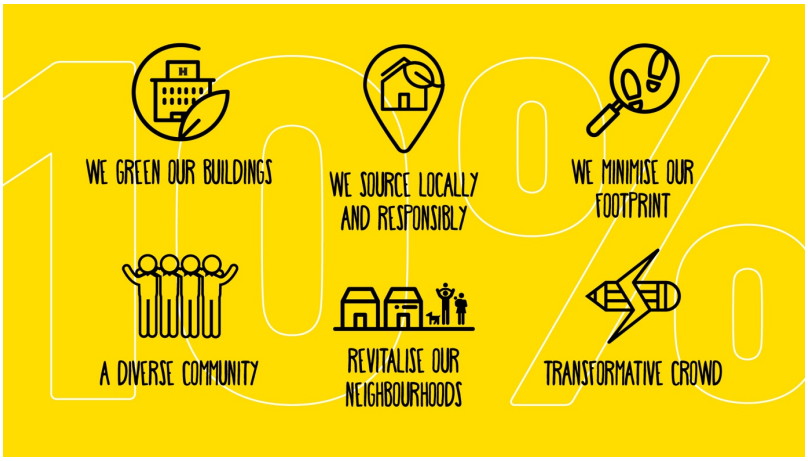


Figure 1.2: The six pillars of TSH CSR strategy (TSH, CSR manual)

1.4 Problem Statement

Based on the background information provided above, the problem statement follows:

Climate change presents an urgency for emissions reduction. The EU and Dutch governments have committed to this reduction. Both have also set forth a vision for a circular future. The real estate industry is well positioned to take advantage and make an impact within the new circular future. The hotel industry will benefit from reduced resource use and is also committed to reducing emissions and investigating circularity initiatives, but more research is needed to understand what circularity is and how it can be applied to the built environment. Therefore, within the context of hotel buildings and operations, more research is needed to understand the strategic and operational considerations of implementing circularity initiatives in hotel buildings and operations.

1.5 Research Objective

In reaction to the problem statement and in light of current legislation and sector outlook, the objectives of this research are to:

-define circularity
-understand the opportunities for circularity in the built environment
-explore the ways circular initiatives are already being incorporated into hotel buildings and operations
-understand the motivations, advantages and challenges of implementing circularity initiatives in hotel buildings and operations
-understand the strategic and operational considerations of implementing circularity initiatives in hotel buildings and operations

In order to inform hoteliers on how to use their position as real estate owners to reduce emissions through circularity.

1.6 Research questions

Main research question:

What are the strategic and operational considerations for implementing circularity in hotel buildings and operations?

The focus of this research question is on:
Actor: the hotel owner
Object: the hotel building
Subject: circular initiatives in buildings and operations

Considerations can include facts or motives taken into account when deciding to implement a circularity initiative instead of a traditional initiative.

In order to answer the main research question, a series of sub-questions will be answered through the research methodology described in chapter 2. They are:

What is circularity?
How can circularity be applied in the built environment?
How has circularity been applied to hotel buildings and operations?
What have been the motivations, advantages and challenges of incorporating circularity for pioneering hoteliers?
How is a circular implementation different from a traditional implementation?

What are the strategic advantages and challenges for implementing circularity?
What are the operational advantages and challenges for implementing circularity?

1.7 Conceptual Framework

For this research, a conceptual framework is used, see figure 1.3. The conceptual framework depicts the key variables in the research and the relationships between them (Miles and Huberman, 1994). The framework is used the analyze the variables of hotel buildings and operations and the relationships between them. The framework is explained below.

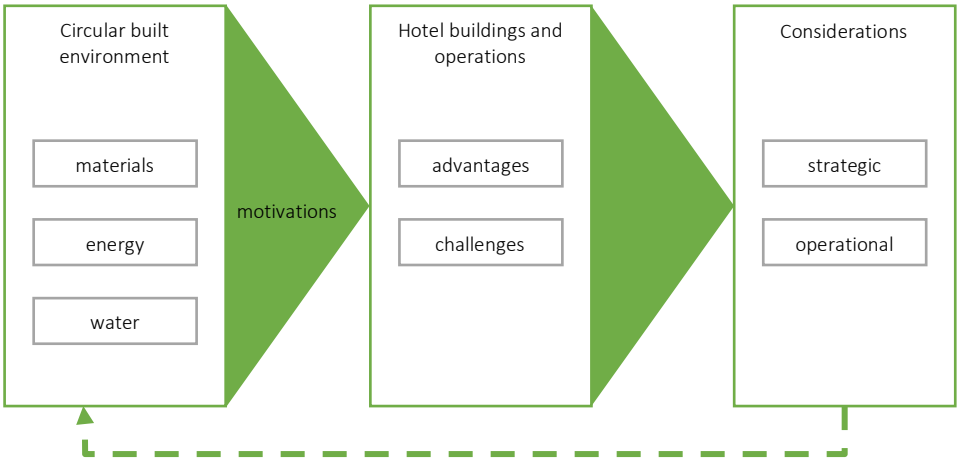


Figure 1.3: Conceptual framework (own illustration)

Through theoretical and empirical research, the aspects of a circular built environment were concluded to be: materials, energy and water. More about this can be seen in chapter 3. These aspects will then be researched through case studies. The motivations for implementing circular initiatives in hotel buildings and operations will be investigated. For hotels that have decided to implement circularity, the advantages and challenges will be researched. When a hotel owner or real estate manager is deciding between circular or traditional initiatives, there are strategic and operational considerations that should be taken into account. These will be researched and documented providing the conclusions of this research and a feedback loop can be drawn from the considerations to the original implementations of a circular built environment. This will be discussed in the recommendations.

1.8 Conclusion

Hoteliers are in a unique position as real estate owners to contribute to global emissions reductions through the implementation of circular initiatives in buildings and operations. This comes with a set of uncertainties that will be investigated through this research, including the motivations, advantages and challenges associated.

The aim of this research is to provide a hoteliers, with the information needed to make informed decisions about (1) implementing circularity initiatives into buildings and operations considering the (2) strategic and operational outcomes of doing so.

2 Methodology

In this chapter the methodology behind this research is explained. First, the type of study and research design will be presented. Next, an explanation on the use of case studies, their selection criteria and those selected and a critical look at the considerations in case studies. Then, data collection and analysis will be introduced. Following a synthesis of the information obtained and lessons learned a framework will be made. This will be reviewed by a panel from TSH to validate findings and understand their considerations when implementing circularity.

2.1 Type of study

The objective of this research is to understand the hotelier's position as a real estate owner to implement circular initiatives. This involves understanding the contextual drivers of implementing circularity and the effects. This research is qualitative in that it seeks to gain understanding of existing phenomenon and draw lessons through comparative case studies that can be used in future applications (Bryman, 2012). Qualitative data collection methods used will include semi-structured interviews, case studies and a panel discussion.

2.2 Research design

To answer the main research question and the objective of this research a series of steps are followed. These steps are according to Bryman's (2012) main steps of qualitative research and provide a path for exploration, in-depth study and synthesis of research with an outcome for future hotel buildings and operations. Step 1b and 6 are added by the researcher to help facilitate the steps and validate research. In this section the steps of the research process will be described, along with the objective and methodology of each step.

Step 1a: General research question

This research began with an exploratory literature review into the topic of circularity and the hospitality industry. The goal of this first stage is to familiarize the researcher with the topic they are looking to research and identify any gaps in literature (Bryman, 2012). This research aims to fill a gap in literature that is relevant to science, the sector and society. This exploratory literature review proved an important time to uncover a relevant and interesting topic and was iterative in itself. It was not until just before the P1 presentation that the research gap was identified and the research began to take direction.

Upon familiarization with the topic and the gaps in literature between circularity and the hospitality industry, a general research question was formed. These were used as a basis for the next step, 1b: specification.

Objective	• Select specific topic within broad range of sustainable area transformations • Familiarize myself with topic and relevance • Find gaps in literature
Methodology	Exploratory literature review
Outcome	A gap in literature exists on how circularity can be used to reduce the environmental impact of the hospitality industry
General research question	How can circularity be implemented in hotel buildings and operations to reduce their environmental impact?

Step 1b: Specification

Following the identification of the general research question step 1b aimed to specify what is already known in research through a literature review and what is known in practice through exploratory interviews. This helped to further specify the general research question, further elaborating on the gap in literature and practice and highlighting the relevance of the proposed research topic while allowing for a revision of the conceptual model.

The exploratory interviews and literature review are iterative in nature. The exploratory interviews have a snowballing effect, where contact with one source leads to contact with another and so on (Bryman, 2012). This is helpful for understanding the research topic in practice and establishing connections in the field. Exploratory interviews conducted can be found in appendix 2.

Question	1. What is circularity? 2. How can circularity be applied in the built environment? 3. How has circularity been applied to hotel buildings and operations? 4. What have been the motivations, advantages and challenges of implementing circularity for pioneering hoteliers?
Methodology	Exploratory interviews, literature review
Outcome	1. Definition of circularity 2. Definition of how circularity can be applied to the built environment. 3. Examples of hotels that have implemented circularity into their buildings and operations. 4. Including their motivations and advantages and challenges they experienced in implementing circularity.

Step 2: Selection of relevant site and subjects

To further understand how circular initiatives are currently being implemented in hotel buildings and operations this research will explore case studies of pioneering hoteliers. These case studies are selected based on a set of criteria that will allow for cross case comparison and synthesis.

For this research a multiple-case study design will be used to discover similarities and differences among three cases. This is further explained in section 2.3.

Objective	Select case studies that are pioneers in circular hotel building and operations
Outcome	Three case studies selected

Step 3: Collection of relevant data and Step 4: Interpretation of data

Case study research allows for an in-depth understanding of the current implementation of circular initiatives in hotel buildings and operations. A cross-case synthesis leads to an understanding of the motivations, advantages and challenges of these initiatives in practice. Using the conceptual model as a framework, information will be gathered during case study research to revise models made after the exploratory interviews and literature review.

Question	3. How has circularity been applied to hotel buildings and operations? 4. What have been the motivations, advantages and challenges of implementing circularity for pioneering hoteliers?

Methodology	Case studies: in-depth interviews and review of case material towards cross-case synthesis
Outcome	c. Examples of hotels that have implemented circularity into their buildings and operations. d. Including their motivations and advantages and challenges they experienced in implementing circularity.

Step 5a: Conceptual and theoretical framework

Based on the data collected during the case study research a framework is formed. It is this step, coupled with the interpretation of data, this forms the study's findings (Bryman, 2012). This framework is the goal of the research and can be used as a starting point for hoteliers in implementing circularity initiatives.

Methodology	Development of a theoretical framework
Outcome	Theoretical framework for circularity initiatives in hotel development and operations

Step 5b: Tighter specification of research question and Step 5c: collection of further data

Step 5b and 5c are intended to re-examine research questions and data as needed to help insure the validity of the theoretical framework. The development of the framework is an iterative process. This may be descriptively explained in the research or happen within the context of step 5a alone. To increase transparency of the research it is helpful to document this iterative process so that future researchers understand and can follow the process (Bryman, 2012). A case from the graduation company will be used to test the findings from the case studies. This test will provide a comparison between a traditional and a circular implementation.

Question	5. How is a circular implementation different from a traditional implementation?
Methodology	Case studies on three circularity initiatives using TSH as a test case
Outcome	e. Comparison of traditional implementation to circular implementation

Step 6: Expert panel

The use of an expert panel is not specifically listed in Bryman's main steps of qualitative research but can be used as a form of triangulation. Triangulation can be used to cross-check findings and increase the validity of the theoretical framework (Deacon et al. 1998). The intention of the expert panel is two-fold. (1) triangulate research findings validate discrepancies between theoretical and empirical findings (2) reveal strategic and operational considerations for implementing a circular initiative instead of a traditional one.

Question	6. What are the strategic advantages and challenges for implementing circularity? 7. What are the operational advantages and challenges for implementing circularity
Methodology	Expert panel
Outcome	f. Strategic advantages and challenges for implementing circularity g. Operational advantages and challenges for implementing circularity

Step 7: Writing up findings/conclusions

This step is the final synthesis of all research conducted in previous steps. At this point the theoretical framework has been tested and iterated through research and an expert panel. Now the audience must be convinced of the credibility and significance of the interpreted findings. This step provides the final answer to the main research question and illustrates clearly to the audience how this answer was found. It should contribute to the larger body of research and practice in the sectors of (primary) real estate and (secondary) hospitality.

Question	What are the strategic and operational considerations for implementing circularity in hotel buildings and operations?
Methodology	Explorative empirical research
Outcome	Provide advice to hoteliers on strategic and operational considerations of implementing circularity in hotel buildings and operations.

The steps of the research process are summarized below in figure 2.1.

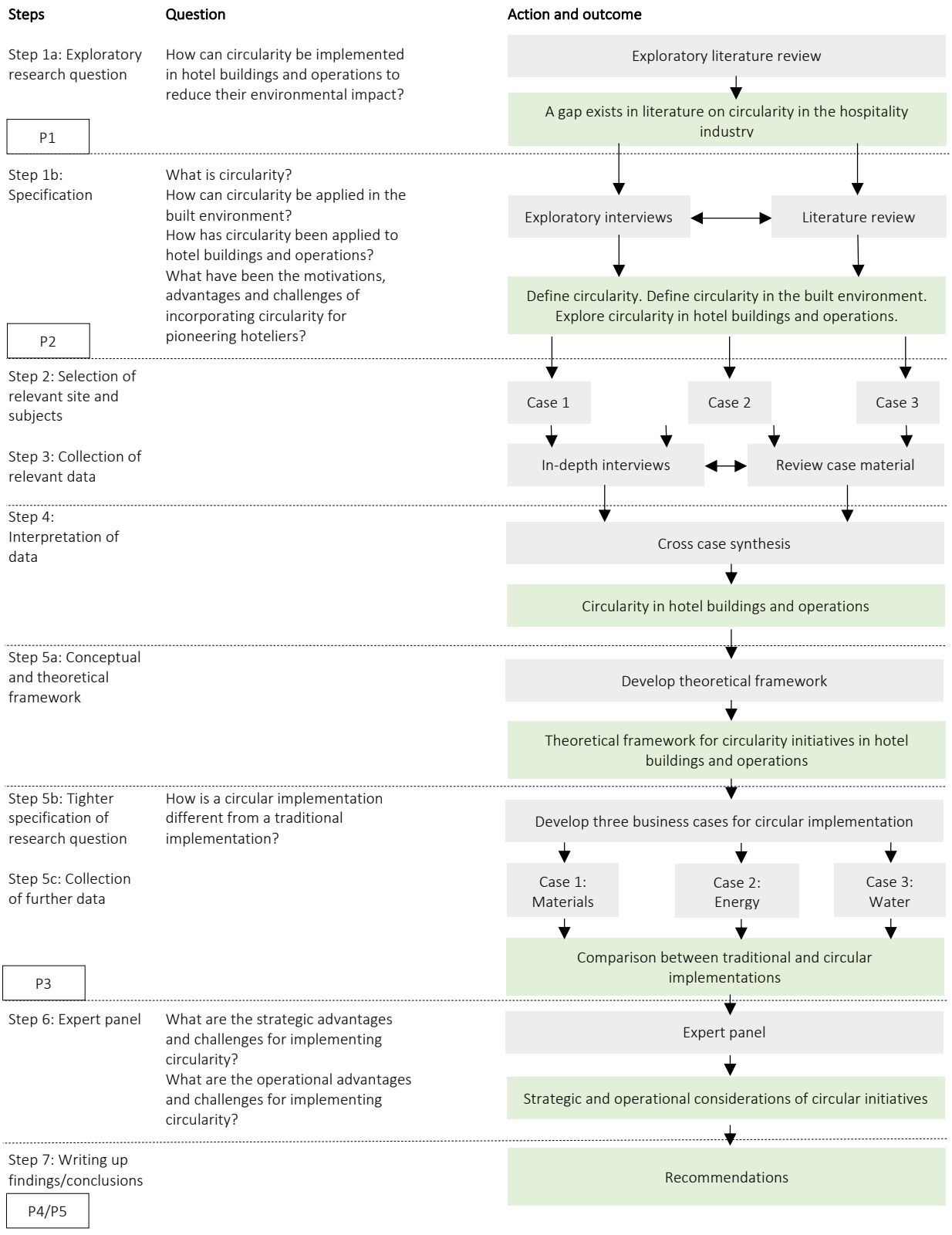


Figure 2.1: methodology, own illustration

2.3 Case Studies

Once the topic has been investigated and preliminary research questions have been selected, data is needed to develop a theoretical framework. This research aims to highlight circular strategies in hotel buildings and operations. As a qualitative research study, the use of case studies is implored as a methodology to gain an in-depth understanding of current practices. Case studies are used to collect, analyze, compare and draw lessons from data. As Heurkens states, researchers in the applied academic fields make use of case studies "to examine contemporary real-life situations and provide the basis for the application of ideas" (2012, p. 119). Multiple cases will be selected with the assumption that similar outcomes will be discovered (Yin, 2014).

Hotel development projects are inherently complex, involving multiple actors and decisions. As Bryman states, "case study research is concerned with the complexity and particular nature of the case in question" (2012, p. 66). The use of case studies in this particular research is to develop a deep understanding of a particular project. To select relevant case studies, the selection criteria is provided below, along with the selected case studies and some things to consider when using case study methodology.

Case study selection criteria

Case study selection is an important step in defining the research scope and depth. In order to make a cross-case comparison, look for patterns between cases and obtain a well-rounded understanding of the subject more than one case needs to be examined. Case study selection criteria are also used to provide transparency into the research process. The following case selection criteria are used:

1. Location: all cases should be located in Amsterdam. This means all cases will be located in an urban setting and adhere to the same legislation, allowing for cross case comparisons.

2. Member of the Circular Hotels Leaders Group: this group consists of 12 hotels in Amsterdam that work together towards circularity goals and have a stated mission to become more circular.

3. Pioneering frontrunner: While the Circular Hotels Leaders Group contains 12 hotels in Amsterdam that are working toward shared circular goals, some have emerged as front runners. Case should be conducted on front runners to gain understanding of the most unique examples.

4. Status: all cases should be completed hotels currently in use. This allows for research to be carried out including the development and operations of the hotel

5. Variety in development and operational management: cases selected should have a variety of development and operational strategies. Boutique hotels developed, owned and operated by one party have a different organizational structure than multi-national hotel chains. Choosing cases with a variety will provide additional possibilities for comparison.

Case study selection

Table 2.1 illustrates the selection criteria against the selected case studies.

Table 2.1: case study selection
Information regarding QO hotel (QO, n.d), Hotel Jakarta (Hotel Jakarta Amsterdam, n.d.), Conscious Hotels (Conscious Hotels, n.d.)

Selection Criteria	QO Hotel	Hotel Jakarta	Conscious Hotels Westerpark
location	Amsterdam	Amsterdam	Amsterdam
Member of Circular Hotels Leaders Group	Yes	Yes	Yes
Pioneering frontrunner, as advertised through mission statement	Yes	Yes	Yes
Status	Opened 2018	Opened 2018	Opened 2018
Development and operational management	Developed by Amstelside B.V., owned by CBRE Global Investors, managed by InterContinental Hotels Group	Owned and operated by WestCord	Owned and operated by Conscious Hotels

Analytical case study model

Bryman describes an analytical model as the "framework to guide the analysis of data" (2012, pg. 566). The conceptual model described in section 2.6 will also be used as the analytical model for this research. This model will be applied to the three selected case studies.

First, the motivations for implementing circular initiatives in hotel development and operations are investigated. Then, the model indicates a relationship between the circular strategies in hotel development and operations and their effects, specifically advantages and challenges. Lastly, strategic and operational considerations for the implemented initiatives will be researched.

This research collects data from three different case studies for the benefit collecting examples from them as pioneers in their industry. These case studies are all conceptually equivalent in their context and goals as described through the case study selection. Pickvance (2001) argues that a conceptual equivalence is needed in order to analyze case studies with the same analytical model.

Data collection

Data collection can range from structured to open-ended approaches and a mix of which can be utilized. Miles and Huberman (1994) illustrate that data collection techniques for qualitative research include examining, asking and watching. These techniques will be used in this research as follows:

Examining: a literature review and document are used to gather practical information about the research topic and cases.

Asking: semi-structured interviews are used to learn about internal motivations for implementing circularity strategies and the effects that they had. Interviews also provide an important opportunity to gain internal insights on a case.

Data analysis

Following the data collection, the meaning of the data will need to be analyzed to further understand the meaning. Miles and Huberman (1994) illustrate the following three steps for data analysis:

1. Data reduction: the process of selecting, and simplifying data
2. Data display: organizing and presenting reduced data
3. Conclusion-drawing: deciding what data means

For this research, data is collected through case studies and displayed using the analytical model. These results are then displayed visually to be able to understand patterns, differences and similarities between the case studies.

Critiques of case studies

This research methodology makes use of case studies in addition to theoretical research to develop an intimate practical knowledge of the subject. According to Flyvbjerg (2006) critics of case study research would say that general theoretical knowledge is more valuable than practical knowledge. Flyvbjerg compares theoretical knowledge to a beginner's proficiency and to be able to really understand a subject, a researcher must perform practical research, of which case studies are a great tool. He describes these critiques of case studies really as misunderstandings that can be explained.

Another misunderstanding of case study research is that it contains a bias toward verification of the researcher's preconceived notions. Flyvbjerg (2006) points out that this is a good critique because it makes qualitative researchers sensitive to this possibility, case studies are more likely to provide a falsification for a researcher's bias. This occurs because researcher's often find that through in-depth case study learning their preconceived views were wrong and they are compelled to alter their hypothesis. When conducting this research, the researcher will of course have preconceived views about the topic, grown from theoretical research and a maturing understanding of the subject. While performing case studies it is important to recognize this potential bias, but more likely existing views will be altered.

Critics of case studies also describe the difficulty to summarize such an in depth and rich body of information as a drawback. Flyvbjerg (2006) states that good case studies should be valued and read in their entirety. He questions the reasoning for wanting to summarize a case study at all when that diminishes its value.

2.4 Practical test case

Following the case study research and development of a theoretical model a case from the graduation company will be used to test and validate findings. Bryman (2012, pg. 387) describes this step, "a theoretical position may emerge in the course of research and may spur the collection of further data to test that theory. This kind of oscillation between testing emerging theories and collecting data is a particularly distinctive feature of grounded theory". In this research the results gathered from case studies will be tested for practical implications through use of a test case.

2.5 Expert panel

Following case study research and a theoretical model of the findings for circular strategies in hotel development and operations and recommendations are developed for hoteliers. An expert panel is the next step in the methodology. The objective is to validate findings and discuss practical considerations for implementing circularity.

Bryman (2012) describes two ways of validating results through the use of expert meetings. For this research an expert panel is chosen over expert semi-structured interviews to allow the panel to conduct a dialog about the subject.

Expert panel participants

The expert panel will discuss the practical cases tested within a TSH project, for this reason, the expert panel should be made up for stakeholders within the TSH organization that can sign off on the initiatives to be implemented. This will include members of the development team, design team, procurement team and banking advisors.

2.6 Research Ethics

Before the P2 the researcher read the "regulations and guidelines for Human Research" provided by the TU Delft Human Research Ethics Committee. The proposed research does not appear to contain any major ethical issues.

This research does propose interviews with humans and the collection of private company information. If desired by the interviewee information can be anonymized to protect the identity of the person or company involved.

2.7 Conclusion

The methodology of this research has been designed to conduct a high-quality qualitative research investigation. It has been updated throughout the research process as needed.

3 Theory

This chapter will introduce the main concepts and theories researched in this report and provide the background information needed. The main topics introduced are the urgency of emissions reductions, how a transition to the circular economy can reduce emissions, the role of real estate in the circular economy, the possibilities for hotels regarding circular real estate.

This chapter will explore and answer sub-questions 1-4. These questions were:

1. What is circularity?
2. How can circularity be applied in the built environment?
3. How has circularity been applied to hotel buildings and operations?
4. What have been the motivations, advantages and challenges of incorporating circularity for pioneering hoteliers?

3.1 Resource use

3.1.1 Climate change and the Paris Climate agreement

Recognizing the urgency of climate change, 195 countries have come together to sign the Paris Climate Agreement. The agreement recognizes the threat of climate change based on scientific data on the rise in global temperature, which has steadily risen since the industrial revolution.

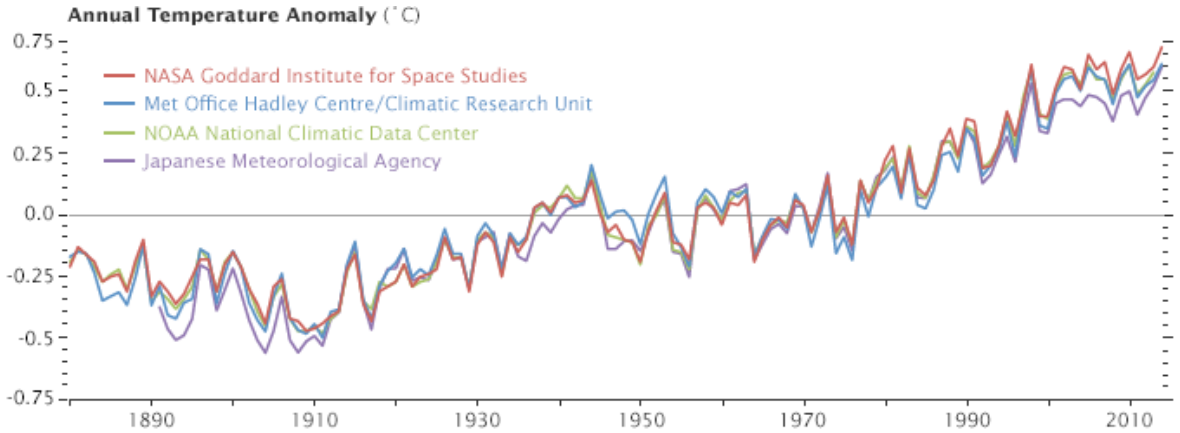


Figure 3.1: Annual temperature over time (NASA, 2010)

Greenhouse gas emissions are directly linked to the average global temperature. Carbon dioxide is the most abundant greenhouse gas, accounting for 2/3 of all greenhouse gas emissions, as seen in figure 3.2 (United Nations, n.d.). The agreement aims to "strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty" (United Nations, 2015, p. 3). This includes a commitment to science-based targets, calling for a limit to the increase in global average temperature to below 2° C above pre-industrial levels and the effort to limit temperature

increase to 1.5° C above pre-industrial levels (United Nations, 2015). In pursuit of these goals the EU agreed to a 40% reduction in greenhouse gas emissions from 1990 levels by 2030 and a 27% increase in renewable energy use (European Council, 23-24/10/2014, 2014).

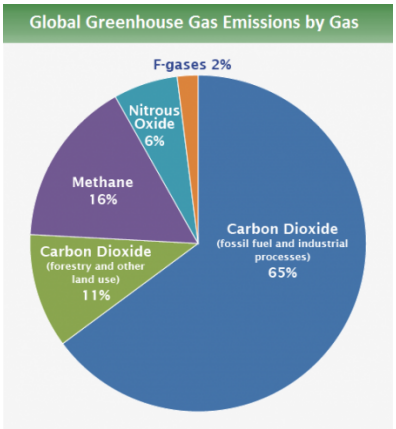


Figure 3.2 Global greenhouse gas emissions by gas (IPCC, 2014)

The non-government organization, Climate Action Tracker has determined that the targets set forth by the EU are insufficient to reach the goals of the Paris Climate Agreement. If all countries had the same emissions reductions ambitions as the EU, global temperature would still be predicted to rise 3° C (Climate Action Tracker, 2019). In 2018 the EU announced refined emissions reduction goals to 55% below 1990 levels by 2030. Implementing these new goals would better position to EU to reach the Paris Climate Agreement's temperature targets (Climate Action Tracker, 2019).

3.1.2 Resources and the built environment

The building industry has the potential to make a big step towards emissions reductions and the transition towards a circular economy. In the Netherlands, the construction industry uses 50% of all raw materials, accounts for 40% of the total energy consumption and 30% of total water consumption. Additionally, 40% of waste in the Netherlands is construction and demolition waste. The construction industry is also responsible for 35% of CO2 emissions. Eliminating emissions from the use of buildings would almost entirely reach the goals of the Paris Climate Agreement (Ministry of IE I&M EA., 2016).

In the United States, 26% of all waste comes from construction and demolition. From this only 20-30% is recycled or reused as seen in figure 3.3. This waste typically occurs because buildings are not designed to be dismantled and reused. The waste that is currently being discarded could be reused for other building materials such as wood flooring or road building materials.

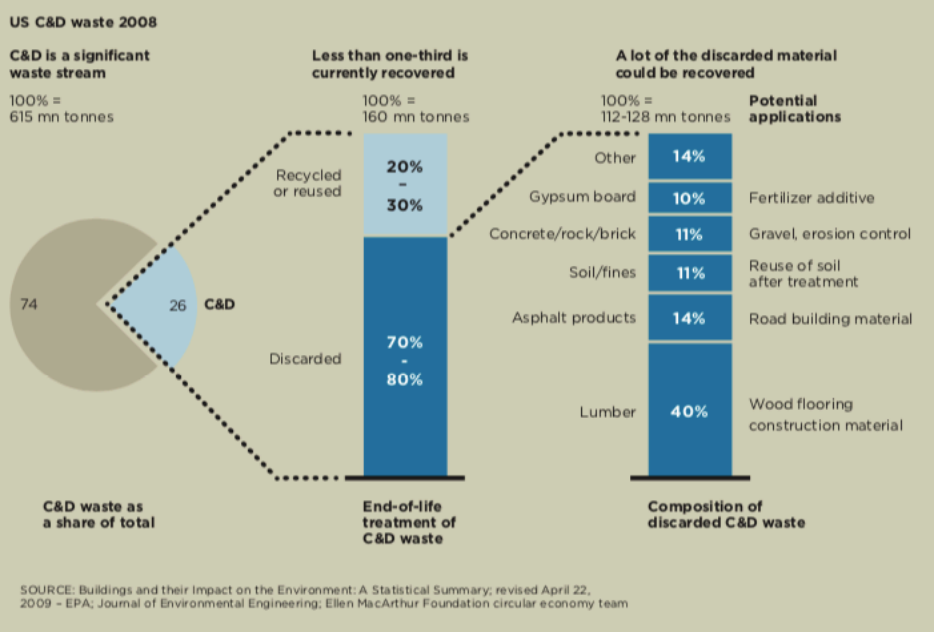


Figure 3.3: Construction and demolition: A noteworthy opportunity (Ellen MacArthur Foundation, 2013) from Buildings and their Impact on the Environment: A Statistical Summary; revised April 22, 2009 – EPA; Journal of Environmental Engineering; Ellen MacArthur Foundation circular economy team

In the Netherlands, construction and demolition waste is reused by civil works. While this is a good reuse of material, the market will eventually saturate, as seen in figure 3.4. Currently, the construction industry only uses 3-4% of recycled materials, leaving a large opportunity to incorporate more recycled or reused materials (Rijswaterstaat, 2015). The Netherlands building industry could become more circular by adopting the suggestions provided in figure 3.3. for recovering material instead of reusing it in civil works.

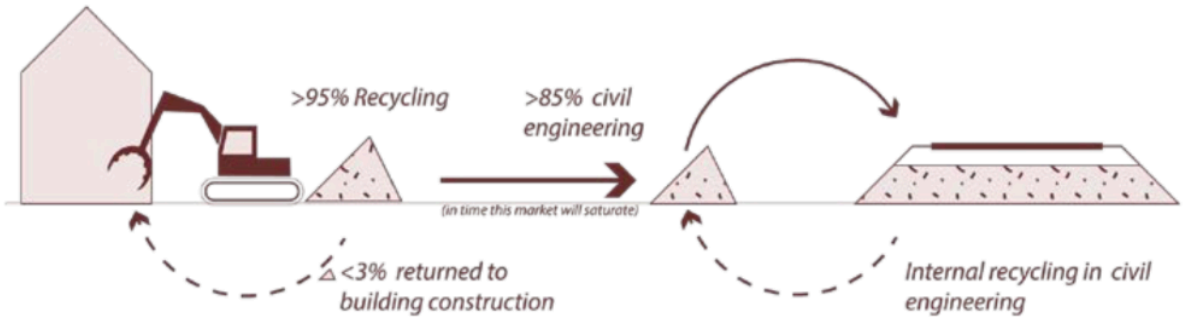


Figure 3.4: Demolition recycling in the Netherlands (Rijkswaterstaat, 2015)

The high resource use of buildings and construction paired with depletion in availability and increase in demand poses a risk for future real estate development. If done correctly, the building industry can become a champion of future sustainable development, meeting the functional demands for buildings but also providing positive impacts on energy, waste and water (Anintk, Carrigan, Bonetti and Westaway, 2014).

3.2 Understanding the circular economy

Following the Paris Climate Agreement signatories have begun implementing their own strategies to reduce greenhouse gas emissions and mitigate climate change. The UN urges that, "delaying mitigation efforts beyond those in place today through 2030 is estimated to substantially increase the difficulty of the transition to low longer-term emissions levels and narrow the range of options consistent with maintaining temperature change below 2 °C relative to pre-industrial level" (UN, 2014, p. 12).

The challenge to reduce emissions is great. Humans have developed products in a linear way since the industrial revolution, capitalizing on the linear model of 'take-make-dispose' to extract resources from the earth, sell them to the consumer and dispose of them when they are no longer needed. This model continues today and has led to an ever-increasing amount of raw materials to be taken from the earth and disposed of without being repurposed. This linear model of consumption leads to a loss in value of materials and negative externalities along the material chain. It is also called the linear economy because profit is made from making and wasting resources. Transitioning from a linear economy to a circular economy provides a solution for reducing emissions while also designing out resource depletion (Ellen MacArthur Foundation, 2013)

Defining the circular economy is a difficult task. One researcher analyzed 114 different definitions of the circular economy provided by 148 different articles and found that only 77% of articles analyzed provided a definition of the circular economy (Kirchherr et al., 2017). Kirchherr et al. (2017) urge researchers working on circular economy concepts to adopt a definition of the circular economy in their work given the conceptual confusion on the topic. While they found a low degree of consensus between researchers, the most commonly accepted definition is provided by the Ellen MacArthur Foundation (2013):

"Circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models."

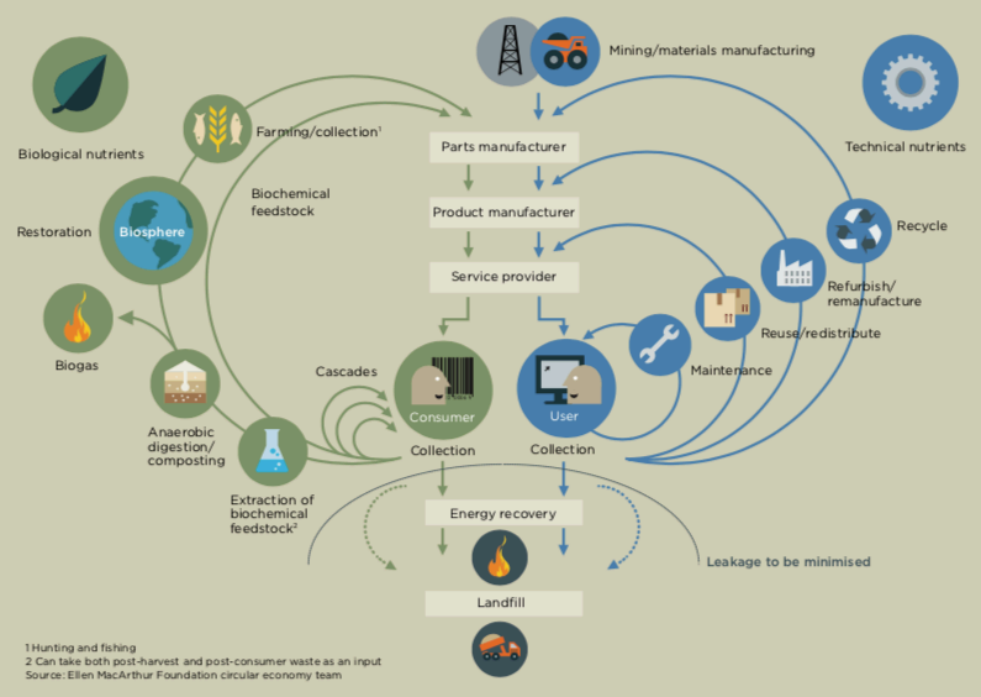


Figure 3.5: The circular economy – an industrial system that is restorative by design (The Ellen MacArthur Foundation, 2013)

In a circular economy the future life of waste products is redefined beyond a landfill. Waste products can be repurposed and upcycled into new products, as shown in figure 3.5. This framework for a circular economy provides four ways to increase material productivity that provides for changing the run rate of required material intakes. These four sources of value creation are (Ellen MacArthur Foundation, 2013):

1. The power of the inner circle: minimizing comparative material usage – therefore reducing greenhouse gas emissions and water use
2. The power of circling longer: maximizing the number of consecutive cycles and the time of each cycle
3. The power of cascaded use: diversifying reuse across the value chain substituting for an inflow of virgin materials
4. The power of pure circles: increase collection and redistribution efficiency extending product longevity and material productivity

3.2.2 Schools of thought

While this definition from the Ellen MacArthur Foundation is the most used in academic literature, it is based on a collection of previous schools of thought. The following schools of thought and their founders can be seen in table 3.1:

Table 3.1: Schools of thought used to develop the circular economy (EMF, 2013)

School of thought	Year	Founder	Description
Regenerative design	1970's	John T. Lyle	"all systems, from agriculture onwards, could be orchestrated in a regenerative manner"
Performance economy	1976	Walter Stahel	"economy in loops…with four main goals: product-life extension, long-life goods, reconditioning activities, and waste prevention. It also insists on the importance of selling

			services rather than products…now more widely subsumed into the notion of 'performance economy."
Cradle to cradle	2002	Michael Braungart and Bill McDonough	"focuses on design for effectiveness in terms of products with positive impact. Perceives the safe and productive processes of nature's 'biological metabolism' as a model for developing a 'technical metabolism' flow of industrial materials. 3 key principles: 1. Waste equals food' 2. 'Use current solar income' 3. 'Celebrate diversity'
Industrial ecology		Roland Clift	"The study of material and energy flows through industrial systems. creating closed-loop processes in which waste serves as an input, thus eliminating the notion of an undesirable by-product. sometimes referred to as the 'science of sustainability'"
Biomimicry		Janine Benyus	"new discipline that studies nature's best ideas and then imitates these designs and processes to solve human problems. Relies on three key principles: 1. Nature as a model 2. Nature as a measure 3. nature as a mentor"

Drawing from the schools of thought in table 3.1, the circular economy is based on a few simple principles:

- Designing out waste
- Build resilience through diversity
- Rely on energy from renewable sources
- Think in "systems"
- Waste is food

One benefit of the circular economy is that it decouples revenue from material input, giving the owner the potential to make additional revenue from a material once a product has reached the end of its lifecycle. Other benefits include a chance to improve efficiency and innovation for manufacturers (Ellen McArthur Foundation, 2013).

The benefits to the economy include material savings, mitigation of volitivity and supply risks, positive multipliers, potential employment benefits, reduced externalities and long-term resilience of the economy. For companies this means short term cost benefits and long-term strategic opportunities as well as new potentials for profit in reverse cycle services such as collection sorting, funding and financing of new business models (Ellen McArthur Foundation, 2013).

3.2.3 The 9R framework

In an ideal circular economy, materials from a discarded product retain their original quality and can be used again with the same quality. This means no additional resources are needed to produce a new product and used products do not become waste, but rather materials for new products. Ultimate circularity is achieved when a product chain is closed, and materials can be reused continuously, but this is probably not feasible in practice (Potting et al., 2017). While ultimate circularity is almost impossible to reach, the 9R table shown in figure 3.6 can be used when deciding which circularity strategy offers the most environmental benefits.

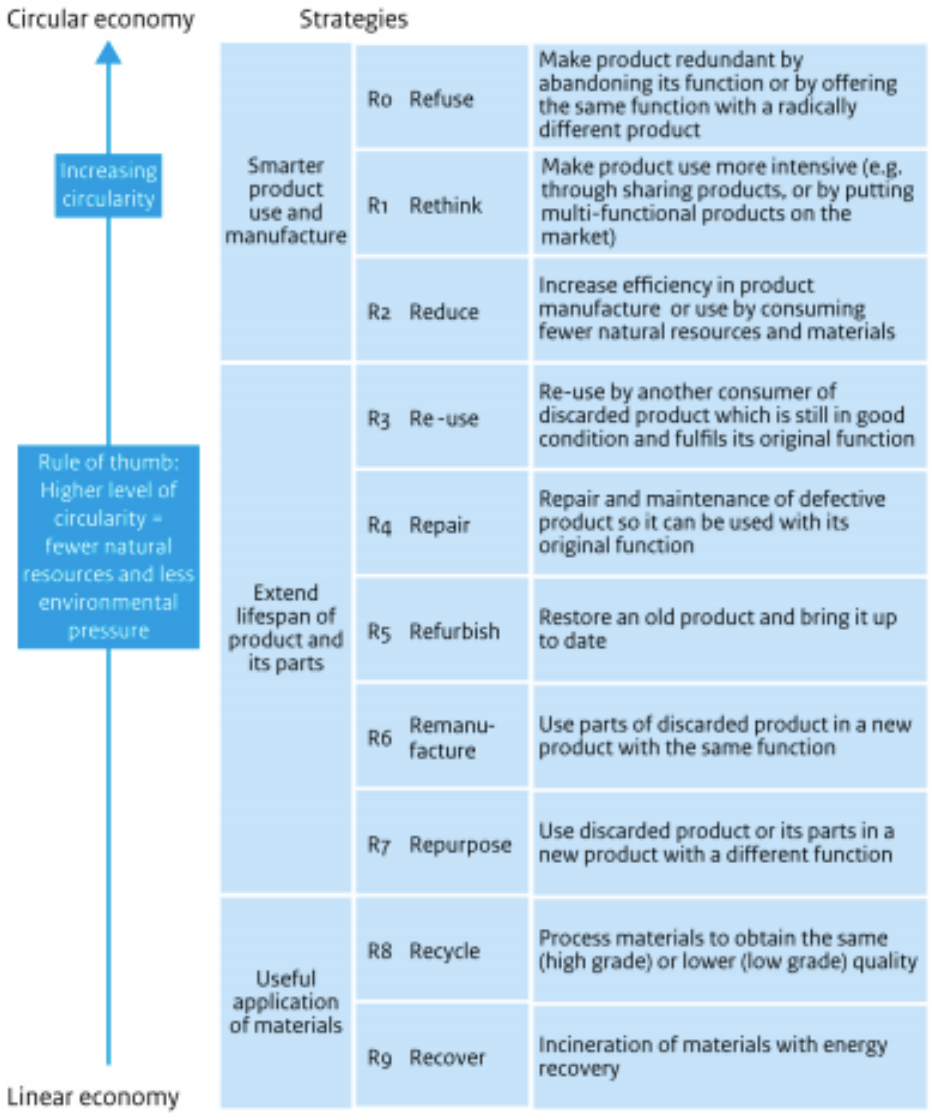


Figure 3.56Circularity strategies within the production chain, in order of priority (PBL, 2016) based on (RLI, 2015)

The R-list establishes a priority order for waste treatment methods. In an R-list, strategies are ordered from high circularity (low-R-number) to low circularity (high R-number). In general, the more circular a strategy is the more environmental benefits it provides (Potting et al., 2017). While the 3R's, reduce, reuse, recycle might be well known, they are not the best strategy toward circularity. Looking at figure 3.6 the best strategy toward circularity is to refuse a product altogether. Re-using a product is relatively circular in the scheme because it does not require new materials to fill the needs of the consumer. Recycling a product is actually quite low on the scheme because recycling requires energy and can lead to a degradation in quality (Potting et al., 2017).

3.2.4 Concepts in circularity

Another concept that is difficult to define Is circular economy versus circularity. In Kirchherr et al.'s analysis of definitions about the circular economy he discovered that in the 114 articles he analyzed they described different aims of the circular economy. The most commonly mentioned aim was economic prosperity, followed by environmental quality, social equity and future generations as seen in table 3.2

(Kirchherr et at., 2017). This puts the emphasis of the circular economy on economic prosperity. Circularity puts an emphasis on the closing of material loops and preserving environmental quality. The main goal is not to make a profit but to extract fewer natural resources.

Table 3.2: coding results of circularity definitions (Kirchherr et al., 2017)

Mentioning of (in sample) … (%)		Full sample	Before 2012	2012 or later	Peer-reviewed	Practitioner
Aims						
Sustainable development (SD)		11	10	12	12	11
All three dimensions of SD		13	10–13	13–14	15	8
	Environmental quality	37–38	42	35–36	41–42	28
	Economic prosperity	46	52	45	44	53
	Social equity	18–20	23–26	16–18	19–22	14–17
	Future generations (time dimension)	1	0	1	1	0
Enabler						
Business models		11	0	14	9	14
Consumers		19	16	20	18	22

Note: Full sample = All 114 definitions.

3.2.5 Conclusion

In this section the concept of the circular economy was investigated. The concept has evolved since the 1970's as an answer to the industrialized linear model of production that is based on a take, make, waste economy. The term circular economy has evolved from previous schools of thought on regenerative design, performance economy, cradle to cradle, industrial ecology and biomimicry (EMF, 2012). It was found that while not one single definition is used, the common aims of the circular economy include economic prosperity, environmental quality, and social equity (Kirchherr et al, 2017). The most commonly used definition of the circular economy is the one used by the Ellen MacArthur Foundation and focuses on a restorative and regenerative design (Kirchherr et al., 2017). Using a 9 step R-list to measure circularity strategies it can be determined that the most circular strategy is to refuse a product. Recycling a product is very low on the R-list because this downgrades the material being recycled. This is why a circular economy is better than a recycling economy (PBL, 2016). Lastly, there is a difference between the circular economy and circularity. The circular economy is focused on economic prosperity. Circularity is focused on closed material loops and the preservation of environmental quality.

3.3 Circularity in the built environment

As mentioned before, the construction and real estate industries are highly resource intensive. The built environment currently demands the extraction of natural resources to be used in building materials, construction, energy production and water use. If the built environment can move from a linear take, make, waste model to incorporate circularity and reuse resources it has the potential to make a large positive impact on overall greenhouse gas emissions (Anintk, Carrigan, Bonetti and Westaway, 2014). This section will investigate circularity in the built environment and how the construction and real estate industries can be leaders in circularity.

3.3.1 Government ambitions

Local legislation is currently driving sustainability in real estate and could soon be driving circularity as well. Following the Energy Performance of Buildings Directive (EPBD), European legislation aimed at reducing building energy use by issuing energy labels ranging from A to G, with A being the best score, the Netherlands adopted the practice as well. According to Dutch legislation all offices will need to have an energy label C by 2023 and the government has stated goals for all buildings to be energy neutral by 2050 (RVO, n.d.). The ambitions of the Dutch government effect all building users. To avoid future

penalties and comply with Dutch legislation, all building owners should consider how they can become energy neutral.

Through the "A Circular Economy in the Netherlands by 2050" agenda, the Dutch government has identified the construction industry as one with the highest priority in the transition to a circular economy. Because of this, the Ministry of Infrastructure and Environment and the Ministry of Economic Affairs has laid out strategic objectives for the construction industry (Ministry of IE I&M EA., 2016). They include:

1. The use of mainly renewable raw materials
2. Optimized use of materials
3. Reduction in CO2 emissions from construction
4. Construction to be innovative and anticipate changes in demand

The agenda also provides a definition for circular building in the construction sector:

"the development use and reuse of buildings, area's and infrastructure, without avoidable depletion of natural resources, pollution of the environment or negatively impacting ecosystems. Construction which is economically responsible and contributes to wellbeing of humans and animals, now and in the future."

While the vision has been laid out, there is not yet legislation in place regulating material use. In the Netherlands, The Building Decree regulates the measurement of the environmental performance of materials. The Netherlands has developed a policy, 'From Waste to Raw Material' (Van Afval Naar Grondstof – VANG) that intends to promote the transition to a circular economy. This has not yet been incorporated in The Building Decree (Rijkswaterstaat, 2015).

3.3.2 Looking at a building in layers

Buildings are not one whole but rather a series of layers that each have their own lifespan. In the 1970s architect Frank Duffy identified four building layers, each with their own lifespan:

Layer	Lifespan
Shell	50 years
Services	15 years
Scenery (interior walls)	5-7 years
Set (furniture)	Monthly

In 1994 Brand built upon this idea and developed the six shearing layers. The layers are divided based on their lifespan and thus in a circular building, can be replaced at different times (Brand 2018). This allows for buildings to be dismantled or reused at rates that are appropriate for their lifespan, avoiding unnecessary waste. The layers include stuff, space plan, series, structure, skin and site as seen in figure 3.7.

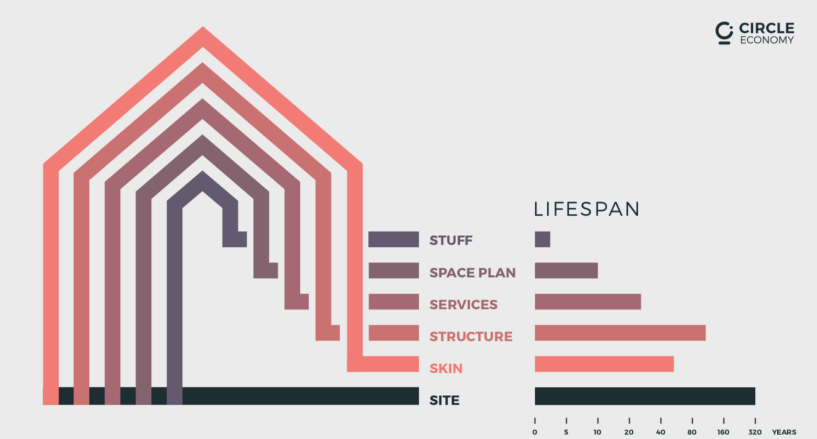


Figure 3.7: 6 building layers adapted from Steward Brand (1995) (Fischer, 2019)

3.3.3 A framework for circular buildings

The Dutch Green Building Council (DGBC) in collaboration with researchers has recently developed a framework that defines circular buildings. The goal of the framework is to set quantifiable standards for circular buildings, in the same way that LEED or BREEAM have done for sustainable buildings. They began by defining a circular building as

"A building that is developed, used and reused without unnecessary resource depletion, environmental pollution and ecosystem degradation. It is constructed in an economically responsible way and contributes to the wellbeing of people and the biosphere. Here and there, now and later. Technical elements are demountable and reusable, and biological elements can also be brought back into the biological cycle." (Kubbinga et al., 2018, pg. 12).

Based on this definition of a circular building the DGBC developed a framework for circular buildings. The framework is applicable for all types of building design and construction. The framework lays out six input areas to consider when developing a circular building, also seen in figure 3.8:

1. Materials are incorporated into the economy in such a way that they can be cycled at continuous high value
2. All energy is based on renewable sources
3. Water is managed in 100% circular fashion
4. Biodiversity is structurally supported and enhanced
5. Human society and culture are preserved
6. The health and wellbeing of humans and other species are structurally supported
7. Human activities generate value in measures beyond just financial

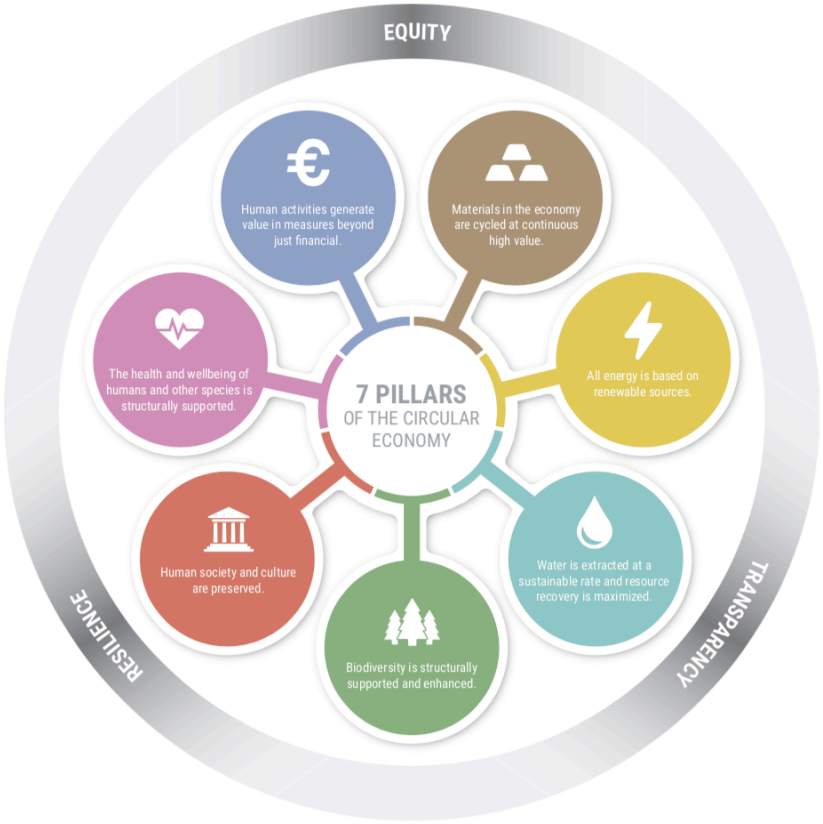


Figure 3.8: The performance characteristics of a circular economy (Kubbinga et al., 2018)

Following the development of the framework the DGBC went on to propose concrete indicators for a circular building. They only developed indicators for the first three impact areas, materials, energy and water and further research was needed to develop indicators for the other four impact areas (Kubbinga et al., 2018).

3.3.4 From linear to circular construction

ABN AMRO in partnership with Circular Economy, the think tank on all things circular, also investigated what is circularity in the construction sector. They deduced that moving from a linear to a circular construction sector involved a radically different from the current linear model. In a circular construction and demolition model the end of life of a building provides value through the recycling and reuse of construction materials. Pre-fabrication can also help reduce construction waste (Van Odijk and Van Bovene, 2015).

Circularity in the construction sector also involves looking at the total cost of ownership. Instead of resources being sold to developers they can be sold as a service and remain in the ownership of the producer waste (Van Odijk and Van Bovene, 2015). This incentivizes producers to build product that last and can be reused in future products. Tools like BIM and material passports help to document the resources in a building and give them a value (Van Odijk and Van Bovene, 2015).

ABN AMRO and Circle Economy see three important things to consider when transitioning from a linear to a circular construction sector (Van Odijk and Van Bovene, 2015):

1. Reducing the impact during the use phase, for both new construction and the existing supply after renovation: the greatest impact of a building in this phase comes from electricity, heating and water use.
2. Optimizing and re-using the existing supply of buildings and infrastructure. Vacancy is currently the greatest inefficiency in the sector: it is important to give renovation and refurbishment priority above new construction, and to introduce more creative solutions for existing buildings
3. Designing future buildings according to circular principles and with circular materials: design for disassembly, re-use and adaptability

Expanding on the third point, a few strategies for designing for circularity are given

- Extended lifespan buildings: protect materials from wind and weather
- Anticipating buildings: adopt to changing demands
- Using standard sizes: provides reusability and higher residual value of materials
- Separating the structural elements from the coverings: increases the adaptability of the structure
- Integrating installation technology into structures
- Using components that can be disassembled: to promote reusability
- Buildings as a resource bank

Looking at the earliest phases of building development, an emphasis is put on materials. By reusing existing buildings, designing for adaption and disassembly and thinking of buildings as resource banks the construction sector can begin to be more circular than linear.

3.3.5 Total cost of ownership

Traditional business and financing models look at only the initial investment costs and not the total cost of ownership. This leads to circular and reversible construction techniques being perceived as too expensive compared to traditional solutions that have been optimized for decades (Debacker et al., 2017). If the built environment is to move from a linear construction and demolition model to a circular one systemic changes are needed. Debacker et al. (2017) present four systemic changes needed to realize a circular built environment:

1. Change in design culture: design buildings to support future change and possible disassembly, design open building systems, educate designers to design for the future
2. Intense collaboration within the entire value network: involve stakeholders, create synergy in building industry, provide reassurance of recycled materials
3. Business creation through product service systems: create win-wins for end-users and manufacturers, create performance-based product services
4. Centralized management of building and material information: centrally store building information, provide transparent and traceable information, use digitalized information to learn

Debacker et al. (2017) acknowledge that this transition will not happen overnight but urge the use of Materials Passports and Reversible Building Design Protocols to get started.

3.3.6 Material Passport

Moving towards a circular built environment involves documenting what materials are already present. One way to do this is through the use of material passport. In the current linear system, our buildings turn mostly to waste after they have served their initial purpose. Often this waste is cremated or sent to a landfill. This can be prevented by giving all materials an identity, documenting them and giving them a material passport. The material passport provides an identity and value to materials already in use, making them available for future use (Rau et al., 2016).

"Waste is material without identity" (Rau, 2016)

Rau and Oberhuber, founders of Turntoo, a company determined to make the circular economy a reality, wanted to give waste an identity to give it the opportunity to be used again. Through the use of a materials passport they are able to identify all materials in new or existing buildings. To keep track of all of the materials and material passports currently available, Rau and Oberhuber developed Madaster. Madaster provides a real estate material register in the form of a public online platform to access these material passports (Rau et al., 2016).

There are other platforms for material passports available such as the Buildings As Material Banks (BAMB) project. The BAMB project is funded by the European Union and aims to increase the value of building materials by promoting materials passports and reversible building design. BAMB's materials passports are designed for materials, products and systems and to understand the value for recovery or design for disassembly (BAMB, 2016).

3.3.7 Measuring circularity

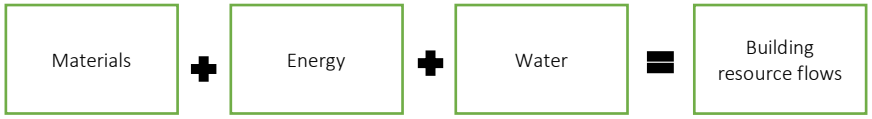
The resources needed for construction of the built environment have already been described. The materials needed for building not only require natural resources but also demand a large quantity of energy even though they cost a minimal portion of the total building construction. When determining the total CO2 emissions of a given material, it is important to look at the entire lifecycle of that material, as emissions should reflect production and future possibilities as well. When deciding on the most circular materials, it is important to apply the life cycle vision and consider economic and environmental costs. Using the Intergovernmental Panel on Climate Change (IPCC) 2007 method of life cycle analysis looks at the entire energy demand for 1kg of material from manufacture, transport, construction, demolition and final disposal (Bribián et al., 2011).

To contribute to a circular built environment, waste materials should be used in place of new materials. It is also necessary to use the best techniques in production of raw materials to minimize the effects on the natural environment. Current building practices make it difficult to disassemble buildings at the end of their life. For the reuse and recycling of construction materials to be possible, design for disassembly needs to be further implemented. Joints between building materials should be reversible and adhesives should be avoided (Bribián et al., 2011).

3.3.8 Conclusion

The Dutch government has identified the construction sector as one of the most important for transitioning from a linear to a circular economy. To do so, the government has enacted laws and presented a vision for a circular future. The focus of the governmental strategy is on material and energy resources. Additionally, the Dutch Green Building Council developed a framework for circular buildings.

This framework extends beyond environmental impact and also includes social and wellness impacts. The scope of this research is on the environmental impacts of the built environment, and therefore will look at the materials, energy and water categories suggested by the framework. This is reinforced by researchers Van Odijk and Van Bovene (2015) who identify the categories of electricity, heating, water and materials to be most important for circular construction. Lastly, Rau et al. (2016) emphasize the need to give materials an identity so that they can be reused in future applications.



3.4 Circularity in the hotel industry

As regulations demand sustainability in real estate and the tourism industry is seeing a growing trend towards sustainable tourism hotels are beginning to take note. A mix of demands are moving the hotel industry towards sustainable hotel buildings and operations and innovative front runners have begun developing for circularity as well.

Strong growth in the hotel industry has led to an increase of hotel development in the Netherlands. So much so that the City of Amsterdam has decided to halt all new hotel development. Citing overcrowding, the city will make an exception for hotels that show that they can add something to a neighborhood or has a strong sustainability focus (Pieters, 2016). The Netherlands has seen a steady increase in hotel guests, as seen in figure 3.9. With the hospitality industry growing, the role that hotels have in contributing to a more sustainable built environment becomes more significant.

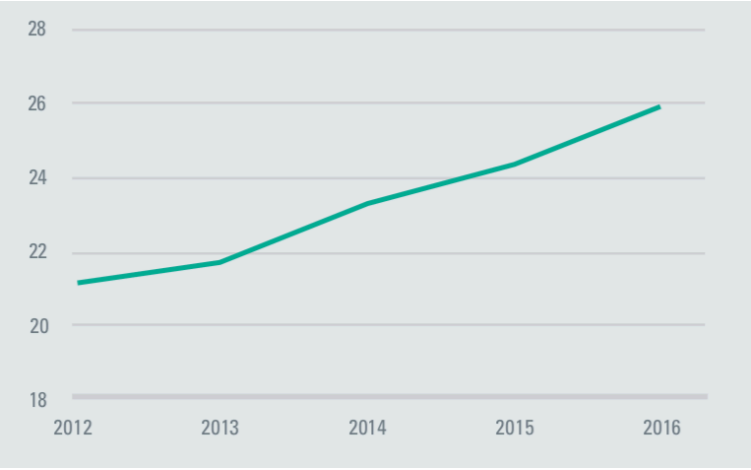


Figure 3.9: Hotel guests in the Netherlands in millions (Driessen and van der Graaf, 2017)

The International Tourism Partnership (ITP), an organization with 30,000 hotel members ranging from small local hoteliers to large international chains, is dedicated to facilitating responsible business in the hotel industry. In 2017, following the Paris Climate Agreement and in line with government initiatives like the Dutch, “Circular Economy in the Netherlands by 2050”, they released a report on hotel decarbonization with the aim of aligning the industry with the goals of the Paris Climate Agreement. In

order to reach the goals set out by the Paris Climate Agreement hotel buildings need to shift their approach on energy use and production, this includes (International Tourism Partnership, 2017):

-Increasing efficiency of equipment and operations
-Increasing the prevalence of renewable energy
-Increasing use of electricity over gas

3.4.1 Growth of sustainable tourism

The demand for sustainable hotels is also growing. With the growth of tourism worldwide and the increased focus on sustainability, hotels stand to gain from participating in this movement. Besides positive publicity hotels can also save money by adopting sustainable practices (Millar and Baloglu, 2008). The International Tourism Partnership broadly identifies a sustainable hotel as one that, "incorporates sustainable thinking in its decision-making at all levels throughout the organization" (2014).

At a U.S. conference of hotel developers focused on sustainable hotel practices attendees cited cost of energy and energy conservation along with water use, cost and availability as the top two environmental issues facing the hospitality industry. Additionally, younger participants were more interested in seeing environmentally conscious attributes in their hotel rooms than older participants, making them the potential target market for sustainable hotels (Millar and Baloglu, 2008).

Travelers are also increasingly seeking out sustainable travel options. Booking.com's annual global Sustainable Travel Report found that 87% of global travelers want to travel sustainably but that only 40% of travelers say that they do so (2018). The idea of traveling sustainably can mean many different things to different people, but 46% of travelers identified accommodation as an important attribute to traveling sustainably. Looking further into the demand for sustainable accommodation, the demand has increased from 62% of travelers in 2016, to 65% of travelers in 2017 and 68% of travelers in 2018. Additionally, 67% of travelers said that they would be willing to pay up to 5% more on their travels to ensure a low environmental impact trip (Booking, 2018). While there is a demand for sustainable travel and travelers are even willing to pay, there are still barriers to sustainable travel. 42% of travelers claim cost is the strongest barrier to sustainable travel while lack of information is the second biggest barrier. 32% of travelers claim that they do not know how to make travel more sustainable (Booking, 2018). The auto industry uses km/l to determine how efficient a car is, electronics use energy labels, but hotels do not have a consistent sustainability rating, making it hard to determine which hotel to choose when making a reservation on a website.

There are a range of rating systems used to measure and identify a hotel as sustainable. Certifications such as LEED, BREEAM and Green Globe aim to certify how sustainable a hotel's physical building is. Other certifications such as Greenkey focus on operations and management. There are hundreds of other certifications in the tourism industry alone. Different certifications are more prevalent in different parts of the world. This can be confusing for travelers looking to book a sustainable hotel. Additionally, this information is hard to find as online booking websites also use different certification ratings, such as Booking.com's "eco-certified" label (Booking, 2018). Despite this, Booking.com finds that 68% of travelers prefer a sustainable or "green" hotel.

3.4.2 Customers willing to pay for green initiatives

In the Netherlands, business travelers are also increasingly choosing for sustainability in hotels. 33% of all Dutch companies do not allow employees to stay at hotels with no sustainability label when traveling for business (Driessen & van der Graaf, 2018). With individuals and business travels increasingly demanding sustainable accommodation options, there is space for this market to grow.

The hotel industry has the potential to become the conduit for social behavior changes in sustainability. By installing sustainable technology that is also visible to guests, they can lower their own impact while promoting conservation (Kang et al., 2012). Consumers are also willing to pay extra for products or services associated with initiatives they are concerned with, such as sustainability initiatives (Simon, 1995). Additionally, in a survey of U.S. consumers' willingness to pay more for a hotel making efforts to be environmentally sustainable, 30% of respondents said that they would. Furthermore, 37% of total respondents said they would be willing to pay an extra 1-5% while 24% said they would pay 6-10% extra and 5.5% said they would be willing to pay more than 10% extra. This shows in total 6% of respondents would be willing to pay more for a hotel that makes efforts to be environmentally sustainable, see figure 3.10. Luxury and mid-priced hotel customers show a higher wiliness to pay for sustainability initiatives (Kang et al., 2012)

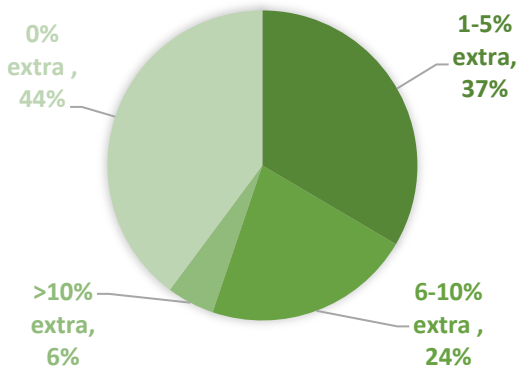


Figure 3.10: Consumers' willingness to pay for hotels making an effort to be environmentally sustainable, own illustration based on Kang et al. (2012)

3.4.3 LEED certification and hotel performance

LEED (Leadership and Excellence in Environmental Design) certification is a rating system used to measure sustainability in buildings since 2000. The system awards credits to buildings that meet it's requirements in seven categories of construction and operation practices:

- Location and transportation
- Sustainable sites
- Water efficiency
- Energy and atmosphere
- Material and resources
- Indoor environmental quality
- Innovation

Different types of buildings are rated against different credits, recently the LEED system introduced a LEED for hotels rating specifically designed to rate sustainability initiatives in hotels (Walsman et al., 2014). While LEED does not specifically measure circularity, it does measure aspects that would also be included in circular real estate, such as materials, energy and water efficiency as well as innovation.

A study of 93 LEED certified hotels compared to 514 non-certified competitors found the LEED certified hotels to have a superior financial performance to the non-certified competitors in the United States. The LEED certified hotels were able to ask $20/night than non-certified hotels, see figure 3.11. Additionally, after certification the LEED hotels had an advantage in revenue per available room (RevPAR) as well, as seen in figure 3.12. This is significant because many hotels have a hard time raising rates, but these LEED certified hotels were able to do so. Research on the financial benefits of LEED certification have been both positive and inconclusive. This research specifically focused on the benefits of LEED for hotels see an advantage in both average daily rate and revenue per available room compared with non-certified hotels (Walsman et al., 2014).

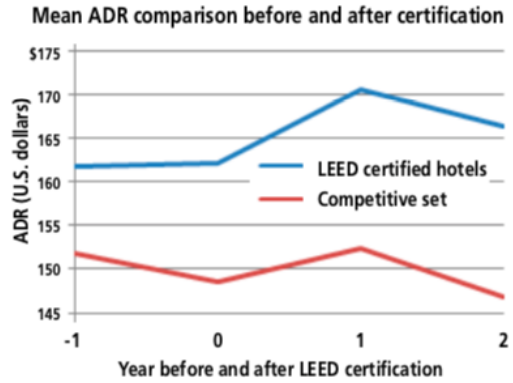


Figure 3.11: Mean average daily rate comparison before and after certification (Walsman et al., 2014)

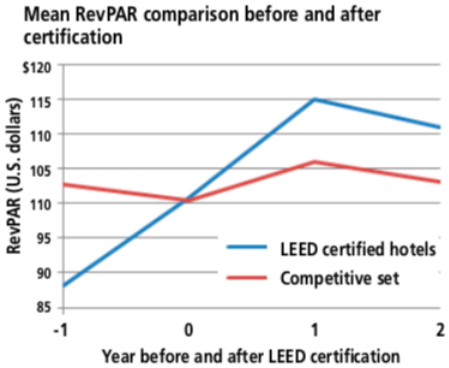


Figure 3.12: Mean RevPAR comparison before and after certification (Walsman et al., 2014)

3.4.4 Motivations for sustainability in hotel real estate

Legislation

The Energy Performance of Buildings Directive (EPBD) requires all office buildings to have an energy label C by 2023 and A by 2030. This legislation is expected to extend to hotels in the future. Additionally, all new buildings must be energy neutral (RVO, n.d.). Additionally, the Dutch government has laid out their vision for "A Circular Economy in the Netherlands by 2050" which provided strategic objectives for the construction industry to reduce material use and CO2 emissions (Ministry of IE I&M EA., 2016).

Tender procedure
Another tool that the Dutch government is using to drive sustainability is tender procedure. The government issues tenders for the new development of land and can set requirements for applicants. For example, for the development of a hotel at the northern most point on the Ijburg Island in Amsterdam, the Municipality of Amsterdam put out an environmentally and socially demanding tender, asking for a solution that included programming for the public and a high degree of sustainability. To meet this demand and win the tender the development team behind the Hotel Jakarta proposed a sustainably sourced wood structure, energy generation through photovoltaic cells and rain water capture and reuse, among other measures (Hotel Jakarta Amsterdam, 2017). This high focus on sustainability allowed them to win the tender and develop the Hotel Jakarta on Ijburg Island. Without the inclusion of sustainable building and operational design, the Hotel Jakarta would never have won the tender, making these features a requirement for the hotel owner.

Internal mission
When not required by law, or by the municipality during a tender, a company can be motivated to include circularity in development if it is in embedded in their mission statement or in-line with company policy. Conscious Hotels, a small chain of environmentally and socially conscious hotels in Amsterdam, was born out of the idea to build a better future. The company states that they, "got worried about their baby's future….and started looking for positive alternatives for…hotels" (Conscious Hotels., n.d.). This motivation has led them develop their hotels in existing iconic buildings, get 100% of their energy from renewable sources, and purchase furniture made of recycled materials (Conscious Hotels., n.d.).

While Conscious Hotels has very personal motivation behind their company mission, motivation can also come from other places. TSH, an international chain of lodging aimed at students and based in Amsterdam also has a motivation to be circular. They are motivated by their clients, stating of their ambitions in circularity, "We've only got an energy label and BREEAM score, but we don't think that cuts it anymore — we need to go the extra mile, inspiring all students who are staying with us." They recognize their position in the market, "With our fast-growing portfolio we've got an opportunity to have a lasting impact across the world." (TSH, 2018).

The Ambassade Hotel in Amsterdam, one of the members of the Circular Hotels Leaders Group, is driven by the interest in supporting a larger social context. They feel responsible for their environmental impact and a need to maintain a high quality of life for the community they are a part of. They have a sustainability plan that strives for circular strategies such as reducing and reusing waste (Ambasaade, 2017).

3.4.5 Towards circular hotel real estate

Improving environmental impact in Dutch hotels
The Netherlands uses the energy label (EPC) to measure the energy efficiency of buildings. 75% of hotels in the Netherlands have an EPC lower than C, meaning they are highly energy inefficient. To improve energy efficiency hotels can consider a range of interventions, each with their own benefits and pay back periods (Driessen and van der Graaf, 2018). Some examples include:

- Optimizing climate installation: for time and temperature
- Energy management: monitoring energy consumption
- LED-lighting: reduce electricity demand and elongate service life
- Solar panels: can also take advantage of subsidies

- Heat pump: minimize energy consumption but have long payback periods

Table 3.3: Measures for making hotel property more sustainable: investment, saving and payback time, own illustration based on Driessen and van der Graaf, 2018

	Energy management			LED lighting			Heat recovery			Electric heat pump			PV cells		
Size of hotel	Investment	Annual savings	Pay back time in years	Investment	Annual savings	Pay back time in years	Investment	Annual savings	Pay back time in years	Investment	Annual savings	Pay back time in years	Investment	Annual savings	Pay back time in years
<1000	2.749	€ 2.61	1,1	€ 9.24	€ 2.51	3,7	€ 2.65	€ 3.83	0,7	€ 27.00	€ 1.36	19,9	€ 18.12	€ 1.88	9,6
1000-2000	€ 2.80	€ 5.33	0,5	€ 21.34	€ 5.78	3.7	€ 5.01	€ 7.28	0,7	€ 39.00	€ 2.08	18,8	€ 40.93	€ 4.67	8,8
2000-4000	€ 3.84	€ 9.82	0,4	€ 44.31	€ 12.02	3,7	€ 9.43	€ 14.60	0,6	€ 66.00	€ 6.25	10,6	€ 67.71	€ 7.20	9,4
4000-8000	€ 4.25	€ 17.77	0,2	€ 68.98	€ 13.80	5,0	€ 14.27	€ 29.19	0,5	€ 72.60	€ 6.92	10,5	€ 89.25	€ 7.46	12,0
8000>	€ 4.35	€ 34.61	0,1	€ 183.91	€ 45.35	4.1	€ 34.49	€ 56.94	0,6	€ 82.40	€ 8.67	9,5	€ 221.69	€ 20.66	10,7

Note: heat recovery is a building specific measure that cannot be applied to all hotels

Table 3.3 illustrates the varying payback periods for these energy saving measures. While not currently mandatory they may be in the future as Dutch legislation on energy labels is tightening for offices and expected to later apply to hotels (Driessen and van der Graaf, 2018).

One way to measure the environmental impact of a material, building or method is through the use of the MKI (milieu kosten indicator, environmental cost indicator in English). Calculating an MKI looks at the entire life cycle and converts the environmental effects into a number using the 'shadow price method". The lower the MKI, the more sustainable, often also meaning lower CO2 contribution and a potential contributor to circularity (Van der Graaf and Driessen, 2017).

By calculating the MKI for electricity, gas, water, food and waste at Dutch hotels it was determined which factors have the greatest environmental impact in euros, thus identifying the greatest opportunities for savings. The average Dutch hotel room has a 1.78-euro environmental cost to society per night with the biggest attributer being electricity, followed by gas, and to a lesser extent waste and food, as seen in figure 3.13 (Van der Graaf and Driessen, 2017).

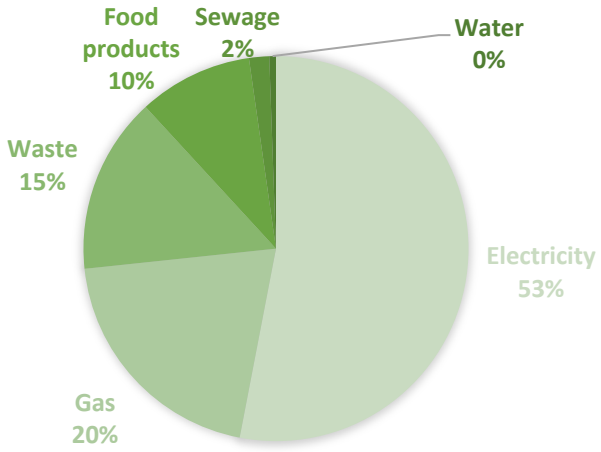


Figure 3.13: Contribution to environmental impact – example hotel. Own image based on (Van der Graaf and Driessen, 2017)

To reduce the MKI effect of electricity hotels should consider renewable energy options. Gas is becoming less of a concern as most new buildings in the Netherlands are required to be gas free. The Mercure

Hotel Amsterdam City piloted the app Winnow to help reduce their food waste. They were able to reduce their food waste losses from 68,000euros/year to 55,000 euros, saving them 12,000 euros and also reducing their environmental impact. To reduce environmental impact of food production hotels can offer more vegetarian and vegan menu items. While water use is not making a large environmental impact, there are savings to be made from reducing water use. Ordinary showerheads consume 11.5liters of water/minute while low flow shower heads can use as little as 4.2liters of water/minute. Throughout an entire hotel this can be a big impact (Van der Graaf and Driessen, 2017).

3.4.6 Circular Hotel Leaders' Group in Amsterdam

Pioneering the sustainable hotel movement in the Netherlands, going a step further and recognizing the potential that circularity has, 12 hotels in Amsterdam have formed the Circular Hotels Leaders Group. They have found that by working together they can take advantage of circular opportunities that they would otherwise not have been able to make use of (CREM, 2018).

While the group is in its infancy stages the members agree on the benefits and are interested in continued collaboration to work towards circularity in their respective hotels and as a larger network. They are investigating projects such collective bargaining for renewable energy production and a shared logistics hub to reduce transport distances (CREM, 2018). Together and with the help of circularity consultant CREM the group has developed a 7-step plan to a circular hotel (CREM, 2018):

1. Make circularity part of your mission
2. Create an overview of your opportunities
3. Use the right terms: it's not waste, it's raw material
4. Challenge your suppliers in the use of raw materials
5. PAAS: pay as a service
6. Motivate your team and get your guests on board
7. Join forces within the chain and within the industry

Additionally, the group came up with a list of circular opportunities for their hotels (CREM, 2018). The full list can be seen in appendix 3. The areas investigated for circularity included:

- Guestrooms
- Kitchen
- Restaurant
- Hotel management
- Procurement
- Reception
- Facility services and technical services
- Roof garden/green roof
- Waste separation
- Energy use and generation

The group is working together to meet circularity goals but have also identified a few challenges they have found. The group notes that more research is needed to understand how hotels can benefit from circularity. They are also looking to understand how to move beyond sustainability and towards circularity, this is still a new and unclear concept. Lastly, they note that national government and

legislation is running behind and should be doing more to encourage circularity (W. Broer, personal communication, November 22, 2019).

3.4.7 Advantages of circularity in hotel real estate

Literature has provided many advantages of sustainability and circularity in hotel real estate. The advantages of sustainable hotel buildings extend beyond the real estate itself but also includes human resources and strategic advantages.

Certification

Hotels that have followed sustainable building or operational practices can apply for an appropriate certification. Green building certifications such as LEED, BREEAM or Green Globe certify the sustainability of the property itself. Greenkey certifies a hotels sustainable management practice. Hotels that have received a certification may be able to ask for higher room rates, and customers have shown a willingness to pay for sustainable hotels (Walsman et al., 2014 and Kang et al., 2012).

Additional Revenues

Hotels that invest in sustainability can also see additional revenues. 66% of consumers are willing to pay extra for environmentally sustainable hotels (Kang et al., 2012). Also, as Walsman et al. (2014) discovered, LEED certified hotels can benefit from additional revenues compared to non-certified hotels. In Walsman's study LEED certified hotels were able to ask a higher average daily rate after certification and receive a higher mean revenue per available room.

Reduce environmental impact and shadow costs

Currently, 75% of hotels in the Netherlands have an EPC lower than label C. If a hotel wants to reduce its environmental impact and improve its EPC label it should implement aspects of circularity to reduce energy consumption. Additionally, most of a hotel's shadow costs, or cost for environmental abatement, come from electricity use. By implementing energy saving techniques such as an energy management system, LED lighting or a heat recovery system, hotels can reduce their environmental impact and shadow costs, also limiting risks to future changes in legislation and availability of energy (Driessen and van der Graaf, 2018).

Limiting risk

The current linear economy is based on the ability to extract and extort resources to produce goods and services. This binds companies to resource prices which have risen steadily between 2000-2010 and are expected to continue to rise. Concerns of resource availability also pose a risk to companies tied to the linear economy (Ellen MacArthur Foundation, 2013). The Ellen MacArthur foundation suggests that businesses can reduce the risks of rising resource prices and availability by "decoupling revenues from material input" (Ellen MacArthur Foundation, 2013, p. 07).

With the goal of making the Netherlands less dependent on importing raw materials, the country is working towards implementing "A Circular Economy in the Netherlands by 2050". The vision states the objective to reduce primary raw materials by 50% by 2030 and has committed to accelerating the pace of the transition to the circular economy. To implement this vision the government has announced a gradual transition from voluntarily stimulating circular development to required measures (Kubbinga, et al., 2018). Planned actions with possible financial implications for businesses include market regulations through carbon pricing and the requiring consumers to pay for the true price of food including externalities (Ministry of IE I&M EA, 2016). Additionally, the Dutch government has stated the ambition

to make all buildings carbon neutral by 2050 (Energy label C Offices, n.d.). Maintaining a linear resource use will have future legislative implications for business.

Competitive advantage

Implementing and promoting circular strategies shows a commitment to sustainability. For a business, showing a commitment to sustainability can help build an advantage in more than one way. Esty and Winston coined the term, "eco-advantage", to describe the competitive advantage that environmental business leaders saw by looking at their business through an "environmental lens". This included opportunities to cut costs, reduce risk, drive revenues and enhance intangible values. This also included the ability to build trust and deeper connections with customers (2009). Specifically, regarding customers attraction and willingness to pay for hotels that have incorporated environmental measures, a positive correlation has been found. A study in the United States looking at the impact of an environmental certification on hotel performance found that customers were willing to pay more per night, and revenue per available room was also when compared to comparable non-certified hotels (Walshman, Verma and Mutulingam, 2014). Additionally, investing in social activities can help save on operating costs while also enhancing reputation (Bird et al., 2007)

The eco-advantage doesn't stop with attracting customers, but also extends to employees. Attracting and retaining talent is one of the top challenges CEO's see for the future. Employees are increasingly value-driven and looking for more than a steady salary. Job seekers are looking for employers that demonstrate a commitment to social and environmental values. Leading employers are gaining a competitive advantage and attracting and retaining talent by incorporating their environmental and social values into their business strategy (Esty and Winston, 2009). They have observed benefits not only in employee attraction and retention but also by inspiring employees, igniting innovation and adding value to their company. As Esty and Winston point out, "other points of competitive differentiation, such as capital or labor costs are flattening, the environmental advantage looms larger as a decisive element of business strategy" (2009, p. 283). Their research also included interviews with recent graduates and job seekers. They found that these potential employees were even willing to take a salary cut in order to work for a company that that cared about the environment.

3.4.8 Challenges of circularity in hotel real estate

In addition to the advantages seen by the pioneering hotels they have also faced challenges. Like the advantages, the challenges extend beyond the hotels themselves and into policy and future planning.

Benefits unclear

Hotels that are working on implementing circularity initiatives are doing so because they see an advantage in it, or think it is the right thing to do. While members of the Circular Hotels Leaders Group also are unclear about the benefits of their work. They are still unsure what is to be gained by their work (W. Broer, personal communication, November 22, 2019).

How to do more

Another challenge faced by hotels that have implemented circularity initiatives is how to do more. Some have been certified as a sustainable hotel or are working as members of the Circular Hotels Leaders Group and doing everything they can to reduce their environmental impact. This leaves pioneering hotels with the challenge to continually improve (P. Lesimanuaja, personal communication, November 21, 2018 and W. Broer, personal communication, November 22, 2019).

Regulation running behind

To be frontrunner on circularity hotels have implemented many innovative solutions. Innovation does not always meet regulation. The frontrunners have had to convince regulating bodies of fire protection levels and ability to meet code. This has been a challenge for hotels that are trying to go beyond regulations in terms of energy standards or material and water use (W. Broer, personal communication, November 22, 2019 and M. Milius, personal communication, March 21, 2019)

3.5 Conclusion

In response to climate change the Paris Climate Agreement proposed reducing greenhouse gas emissions. The largest contributor to greenhouse gas emissions is carbon dioxide. One way to reduce emissions is through the adoption of a circular economy, in which resources do not become waste at the end of their usable life but are restored and reused to eliminate waste. While the circular economy focuses on economic prosperity, circularity alone focuses on closing material loops and the preservation of environmental quality.

Circularity can be used in the built environment to reduce the environmental impact made from construction and building use. The resource flows to consider in a circular building are materials, energy and water. Buildings should be seen in their layers, with each layer having a different life-cycle. The "stuff" inside a building has the shortest life-cycle, maybe single use items, and the structure of a building can have a life-cycle of 100+ years. When considering a building in a circular way, each layer should be considered based on its life-cycle.

Hotel buildings and operations have begun implementing circularity. Certified sustainable hotels are able to charge more for a hotel room compared to non-certified hotels, and customers are willing to pay more for sustainable accommodation. Dutch hotels are motivated by local regulations such as tender procedures and intrinsically to implement circular initiatives.

In innovation and being a pioneer in implementing circularity in hotel buildings and operations hotels have seen many advantages and challenges. Advantages include the ability to obtain a sustainability certification, additional revenues, reduced environmental impacts and shadow costs, limiting risk and gaining and competitive advantage. Challenges include being unclear of the benefits, being unsure of how to do more than a hotel is already doing and regulation running behind.

This chapter has provided an answer to sub-questions 1-4.

1. The literature review provided many interpretations and definitions of the circular economy and circularity including the evolution of the concept which can be traced back to the 1970's (EMF, 2012). The concept of circularity has been suggested to reduce greenhouse gas emissions and reverse the effects of climate change. **The goal of circularity is to close material loops in order to preserve environmental quality and extract fewer natural resources** (Kirchherr et al, 2017).

2. Through the literature review, many ways to incorporate circularity into the built environment were discovered. The construction and real estate industries are significant to reducing greenhouse gas emissions because of their high resource use (UNEP, 2011). The Dutch Government has called upon the construction industry to adopt a circular economy by 2050 in their vision for "A Circular Economy in the Netherlands by 2050" (Ministry of IE I&M EA., 2016). The Dutch government, the Dutch Green Building Council and others have proposed solutions to incorporate circularity into the built environment.

A wide variety of proposed solutions appear in literature, but some can be seen repetitively. A circular built environment should consider three resource flows: materials, energy and water (Ministry of IE I&M EA., 2016 and Kubbinga et al., 2018 and Van Odijk and Van Bovene, 2015 and Rau et al., 2016). This research defines a circular building as a building in which:

Materials are used from entirely reused or recycled or renewable sources
Energy comes from 100% renewable sources
Water leaves the building at the same purity level it came in

Additionally, considering the built environment from a circular perspective should consider a building in layers. The layers of a building have different life-cycles and need to be replaced at different times. Using Brands sheering layers can focus the resource flows of a building to a predefined life-cycle to better make circular decisions about them.

3. Circularity has been applied to hotel buildings and operations through the Circular Hotel Leaders' Group. Their areas of implementation were listed in section 3.4.6.

4. Motivations for incorporating circularity for pioneering hotels has been legislation, tender procedure and internal mission. Advantages have been certifications, additional revenues, reduced environmental impact and shadow costs, limiting risk and gaining a competitive advantage. Challenges have been that the benefits are unclear and how to do more to improve on what they have already done.

4 Case studies in Amsterdam

To gain practical empirical examples of circularity in hotel buildings and operations case studies are used. Case studies were selected based on their ability to meet the case study selection criteria which included (1) location: all projects selected are in Amsterdam (2) member of Circular Hotels Leasers Group (3) pioneering frontrunner in circularity, as described by advisors to the group (4) status: all hotels should be open (5) development strategy: a variety of development strategies were investigated. Based on these criteria three case studies were selected: (1) The QO Hotel, (2) Hotel Jakarta, (3) Conscious Hotel Westerpark.

Data was collected through in-depth interviews and document collection. In-depth interviews were carried out with multiple sources per project to get a more holistic view of the case and to triangulate data (Bryman, 2012). The snowballing method was used, in which one source provided a connection to other sources to provide a more complete picture of a case (Bryman, 2012).

The cases are discussed separately in this chapter. Each case begins with an introduction of the case, providing background information and context to the case study. Next the motivations of the hotel to implement circular strategies are provided. Then the circularity initiatives are presented. Finally, the advantages and challenges of the ambitions of the hotel and specifically the ambition to incorporate circularity are presented.

This chapter will further explore and answer sub-questions 3 &4. These questions are:

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3 How has circularity been applied to hotel buildings and operations?
4 What have been the motivations, advantages and challenges of incorporating circularity for pioneering hoteliers?

4.1 The case of QO Hotel

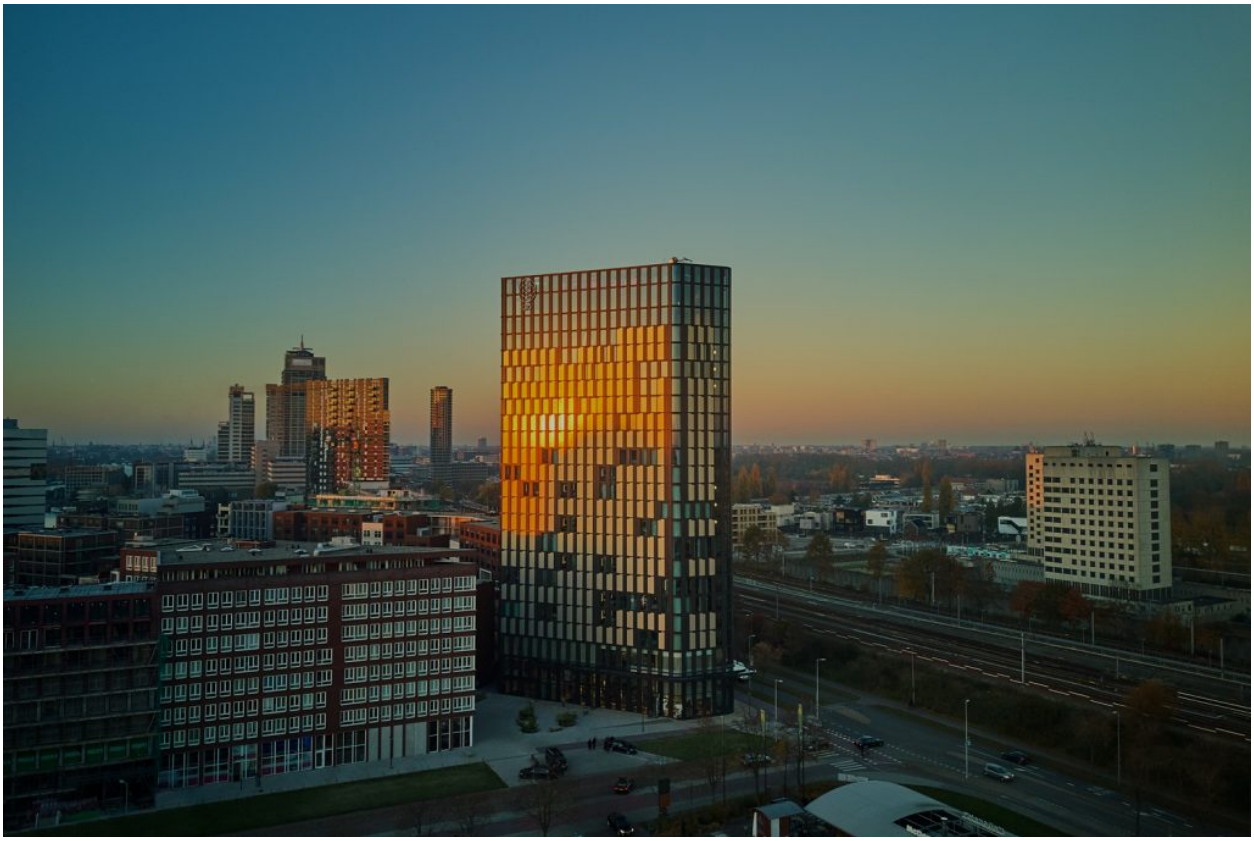

Figure 4.1: The QO Hotel (QO, n.d.)

4.1.1 Introduction

The QO Hotel is a 288 room, new build, high-rise hotel located in the southeast of Amsterdam. Opened in the summer of 2018, the QO markets itself as a "visionary lifestyle destination" and was conceived with sustainability in the forefront (QO, n.d.). The QO aims to create an identity through the use of circularity and design to stand out from other hotels in Amsterdam. By providing ample public space the QO aims to create an experience where travelers and locals can intertwine.

Development strategy

The developer of the QO hotel is Amstelside B.V. Amstelside B.V. is comprised of four stakeholders who each have their own companies. Xander Bueno de Mesquita is one of the stakeholders of Amstelside B.V. and responsible for concept development. Amstelside partnered with Intercontinental Hotel Group (IHG) to manage and operate the hotel after completion under a white label management brand. This means that the QO will maintain its own identity and not take on one of the many brands of the IHG such as Crown Plaza or Kimpton. Shortly after completion the hotel was sold to a CBRE Global Investment Partners. Paul de Ruiter was the architect and ARUP was the engineer. Many other stakeholders were involved as project managers, advisors and consultants (X. Bueno de Mesquita, personal communication, January 23, 2019).

4.1.2 Motivations for circularity

Internal

Before beginning the project, de Mesquita had the ambition to develop the most sustainable hotel in the world. He was not interested in certification or labels like a living building or biomimicry because he felt that once it was labeled, it was no longer innovative. He began by looking into cradle to cradle development and the work of architect William McDonough but soon realized that would not be a good partnership (X. Bueno de Mesquita, personal communication, January 23, 2019). De Mesquita found a compatible architect in Paul de Ruiter who wanted to see out the development of a living building with a chameleon skin (X. Bueno de Mesquita, personal communication, January 23, 2019). Later on, the QO Hotel had the ambition to become the first LEED-Platinum certified hotel in Europe (P. Wenneker, personal communication, January 23, 2019).

Regulatory
Additionally, the city of Amsterdam recently put restrictions on new hotel development. They implemented that all new hotels in certain areas of Amsterdam must meet a certain level of sustainability requirements.

Financial
Lastly, the QO was financially motivated towards circularity by banks. Banks such as ABN AMRO would not provide a loan to developments that were not developing to a certain level of sustainability and innovation.

4.1.3 Circularity initiatives implemented

Materials
Developer de Mesquita envisions that the QO Hotel building will only be used as a hotel for about 15 years. The area in which it sits is a rapidly developing area and a hotel currently makes sense as a luxury hotel. He also envisions that in 20 years or, so it may need to be redeveloped into senior housing. For this reason, the building is designed to be flexibly repurposed. Instead of sticking to typical 5-star brand standards with rooms at 30m2 the QO developed rooms that were 25m2 and could later be converted to 50m2 rooms without much demolition. The building uses 30% recycled concrete. This was possible because the contractor was also demolishing another building nearby. The QO was able to use the recycled concrete from a local building (X. Bueno de Mesquita, personal communication, January 23, 2019).

During the construction phase, the QO aimed to earn LEED points and reduce material waste by minimizing and separating construction waste. Pre-cast concrete was also frequently used to prevent material waste. The interior design team selected materials and furnishings that are designed to be durable but disassembled and reused (J. Zeeman, personal communication, February 5, 2019).

While a green roof would have provided more points towards the LEED certification Amstelside selected for a greenhouse on the roof instead. The greenhouse produces around 4% of the restaurant's food by weight and also includes an aquarium for fish that are served in the restaurant. The greenhouse provides a source of hyper-local food production while also reducing transportation and packaging waste. In another effort to reduce material waste, and in collaboration with the Circular Hotels Leaders Group the QO is reusing fruit scraps to make soap. Lastly, the hotel collects its coffee grounds and gives them to mushroom farmers to be used as natural fertilizer (X. Bueno de Mesquita, personal communication, January 23, 2019 and J. Zeeman, personal communication, February 5, 2019)


Figure 4.2: Greenhouse at QO (QO, n.d.)

Energy

Amstelside partnered with architect Paul de Ruiter to design the world's most sustainable hotel. De Ruiter had wanted to develop an intelligent chameleon façade and the QO was the perfect project to do so. ARUP helped to engineer the façade. When the rooms are not occupied the façade opens and closes automatically to control the internal temperature (X. Bueno de Mesquita, personal communication, January 23, 2019).

Additionally, the QO aims to get 100% of its heating and cooling requirements from a thermal aquifer system. In the warmer months heated water is taken from the hotel and pumped 70m below ground. In the cooler months that water is pumped out again and used to heat the hotel, reducing energy demand and minimizing district heating (J. Zeeman, personal communication, February 5, 2019).

Water

The QO recognizes that water is one of the biggest resource demands of a hotel. For this reason, they aimed to limit water use by using low flow water taps (J. Zeeman, personal communication, February 5, 2019). All water that has been used in a hotel room shower or sink is reused to flush the toilets through a greywater system. In this way, water is used twice throughout the building before being delivered to the waste water system (X. Bueno de Mesquita, personal communication, January 23, 2019).

On the operational side, QO uses ozone water to clean without the use of chemicals. Instead of putting plastic bottles of water in rooms, hotel guests receive two bottles of water in reusable glass bottles, one sparkling and one still. These bottles are filled from the tap using the Made Blue system to cool the tap

water or add gas. Both of these initiatives reduce material use, transportation and waste generation (J. Zeeman, personal communication, February 5, 2019).

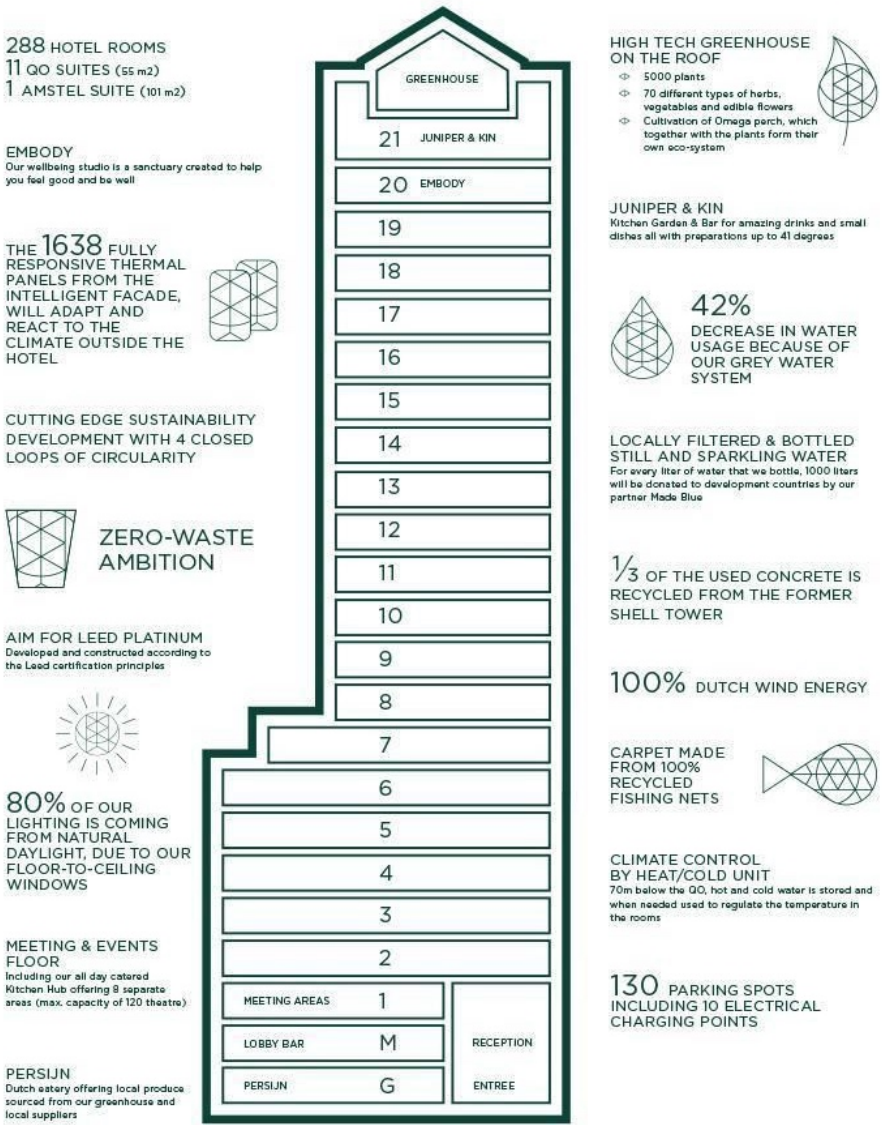

Figure 4.3 Overview of sustainability strategies at QO Amterdam (Paul de Ruiter, 2019)

4.1.4 Overall advantages

Human resources

Since the QO opened in the summer of 2018, they have been able to attract and retain employees who identify with the ambitions to be a sustainable and circular hotel. To be a sustainable and innovative hotel, the QO has opted to reduce printing and use in room iPads to control everything in the room, from lights to the TV. They find that this is a user-friendly way to show guests all of the sustainable features of the hotel as well (J. Zeeman, personal communication, February 5, 2019).

Certifications

Because of the sustainability efforts of the QO they have earned Green Globe certification. This is also a demand of IHG. (J. Zeeman, personal communication, February 5, 2019). The four criteria categories are:

(1) sustainable management (2) social/economic (3) cultural heritage (4) environmental (Green Globe, 2019). The QO has applied for the LEED Platinum certification. If awarded it will become the first LEED Platinum hotel in Europe. While originally against the idea of certifications de Mesquita choose to go with LEED certification because it allowed the most room for innovation. For this project, with high sustainability and innovation ambitions it was important to partner with a good certifier. The QO used a certifier that wasn't afraid to challenge the LEED system and explain how they met the intention of a criteria (X. Bueno de Mesquita, personal communication, January 23, 2019).

Awards
Hotel Property Award 2018: selects one hotel from a shortlist of 12 that stand out from competitors through architecture, design and innovation (Hotel Forum, 2018). The jury said of the QO Hotel:

"The QO Amsterdam won the hotelforum jury over both with its consistently sustainable concept and with its high-quality standards. One might say that the building is a 'living' organism that behaves like a chameleon and at the same time meets the highest criteria in terms of CO2, water, energy and waste management." (Andreas Martin, managing partner of hotel forum)

AHEAD award 2018 as Best Urban Hotel – Newbuild: celebrates hospitality experience and design. Selected the QO for championing sustainability through a plethora of initiatives (Ahead, 2018).

FRAME Sustainability Award 2019 – people's choice: selected for delivering a high-end hotel while also maintaining an overall circular design and integrating sustainability principles in all areas of the hotel (Frame, 2019).

4.1.5 Overall challenges

In development
While Amstelside came with a vision, they faced challenges convincing all project stakeholders that building a flexible living building would add value in the future. It took additional time and patience to find partners that were willing to work on such a project. It also took time to work with the municipality and decide the value of the land, and when to begin to develop (X. Bueno de Mesquita, personal communication, January 23, 2019).

In operations
Because of the high level of innovation in the building, the façade opens and closes on its own, guests use iPads in the rooms, there are higher than normal IT costs. While the building was designed to be as energy efficient as possible, guests use a lot of energy. When staying at a hotel guests might not be as conservative as they are in their own homes because they do not directly pay for energy (J. Zeeman, personal communication, February 5, 2019).

4.1.6 Lessons learned

The QO Hotel was fortunate to have project champions who allowed space for the project to innovate, "with innovation you have to be able in timeline and in budget to make mistakes." (X. Bueno de Mesquita, personal communication, January 23, 2019). Regarding certifications, developer de Mesquita recommended, "Go from your own strength and then look at the certifications which would make sense" (X. Bueno de Mesquita, personal communication, January 23, 2019).

4.1.7 Overview

Table 4.1: Overview of data gathered through in-depth interview on The OQ Hotel

	QO
Interviews	Philip Wenneker - 4Building Xander Bueno de Mesquita - Amstelside B.V Jacqueline Zeeman - QO Hotel
Motivations	Internal: Desire to create a community, using a hotel as the facilitator
	Regulatory: City regulations for only sustainable hotel development
	Financial: Banks such as ABN AMRO won't provide loans for projects that do not reach a certain level of innovation or sustainability
Materials	Building designed to be repurposed
	30% recycled concrete used
	reuse fruit waste to make soap
	give coffee grounds to mushroom farmers as fertilizer
	Minimize construction waste
	Recycled fishing nets used in carpeting, to be recycled after use (interface)
	Wood locally sourced in France and oil used to stain instead of lacquer
	Investing in long lasting materials - designed to be reused - break up into layers of components
	Greenhouse on roof - produces 4% of restaurant's food by weight and fish when possible
	Pre-cast concrete used to reduce material waste
	Minimize kitchen waste
Energy	Intelligent façade
	Thermal aquifer - BOCHP - No heating or AC - goal to use 100% of energy from this
	minimize district heating
Water	Greywater system from shower and sinks in guestrooms reused in the toilettes
	OZONE water used to clean rooms without chemicals
	Made blue - filtered tap water
	low flow taps
Overall Advantages	LEED Platinum
	green globe certified
	User friendly to show guests
	low paper printing costs
	attract and retain employees
	Hotel Property Award 2018
	AHEAD award 2018 as Best Urban Hotel – Newbuild
	FRAME Sustainability Award 2019 – people's choice
Overall Challenges	Guests use a lot of energy
	High IT costs
	Managing project stakeholders
Lessons learned	Create space for innovation, in time budget and physically
	Start with strengths and find a certification to match

4.2 The case of Hotel Jakarta

Figure 4.4: Hotel Jakarta (Hotel Jakarta, n.d.)

4.2.1 Introduction

The Hotel Jakarta is a 4-star, 9 story hotel located on the eastern side of Amsterdam along the Ij river. The site is on Java Island, the former departing point for ships destined for Jakarta, influencing the name and character of the hotel. Opened in 2018, the hotel consists of 200 rooms, most with a balcony, and aims to integrate itself into the community on Java Island (Hotel Jakarta, n.d.) The rooms are situated around an internal atrium that is filled with tropical plants and topped with a glass roof. Amenities include a restaurant, pool and fitness center, rooftop bar and meeting rooms.

Development strategy

The Hotel Jakarta is owned by Westcord Hotels, a family owned Dutch company. The project was conceived by SeARCH architects who had been working on a masterplan for the area for a while. When the tender for the site came up, SeARCH partnered with Westcord to submit a proposal (P. Lesimanuaja, personal communication, November 21, 2018).

4.2.2 Motivations for circularity

When the city of Amsterdam put forth the tender for the hotel site on Java Island, it listed high level of sustainability and contribution to local community as part of the proposal requirements. This included a *menukaart duurzame hotels* (menu for sustainable hotels and is in appendix 2) listing requirements for bronze, silver and gold level of sustainability in hotels. Tenderers were to reach at least the silver or gold level from the *menu* but Hotel Jakarta wanted to do something more to win the tender. This is how they decided to go for a BREEAM certificate (P. Lesimanuaja, personal communication, November 21, 2018 and M. Milius, personal communication, March 21, 2019). Additionally, the city provided a subsidy for attaining the BREEAM excellent certificate (B. Mastboom and R. Griffijn, personal communication, November 21, 2018). The project did not set out to be specifically circular but rather sustainable.

4.2.3 Circularity initiatives implemented

Materials

The leading ambition from SeARCH architects regarding materials was to use as little as possible. The design aesthetic is clean and simple materials. When the contractor is finished with the site there should be nothing else added, minimizing finishes, materials and time. Most of the construction is completed from FSC certified wood and bamboo. This allows for minimal concrete to be used, and when it was, 25-30% was recycled (M. Milius, personal communication, March 21, 2019). Most of the rooms were prefabricated in the Netherlands, limiting CO2 emissions due to transportation from factory to site. The rooms could be constructed very quickly once on site, reducing material waste and saving time on the construction site. As a part of the Circular Hotels Leaders Group the Hotel Jakarta collects fruit scraps to be reused for making soap, reducing waste (P. Lesimanuaja, personal communication, November 21, 2018). The structure is designed to be disassembled, made up of a 30m high wooden support structure, meaning all beams, columns and ceilings are made of wood (Hotel Jakarta, n.d.).

Figure 4.5: Modular hotel rooms (Hotel Jakarta, n.d.)

Energy

To become an energy neutral building the Hotel Jakarta utilizes a variety of energy saving and energy generating techniques. The roof contains 600m^2 of PV cells and 300m^2 of solar water heaters. Additional PV cells are located on the façade and at a distance, on the Fashion Hotel, another one of Westcord's properties. This technique is allowed by BREEAM to reach energy ambitions of one building by located PV cells on a nearby building. There are also 250m^2 of building integrated PV cells in the glass roof above the atrium. The advantages of this feature are two-fold and also provide shading to the atrium. A heat pump is used to heat and cool water from the Ij river next to the site, and then distribute it throughout the building for heating and cooling, using an Aquifer Thermal Energy Storage (ATES) system The building has no forced air heating or air conditioning system (M. Milius, personal communication, March 21, 2019).

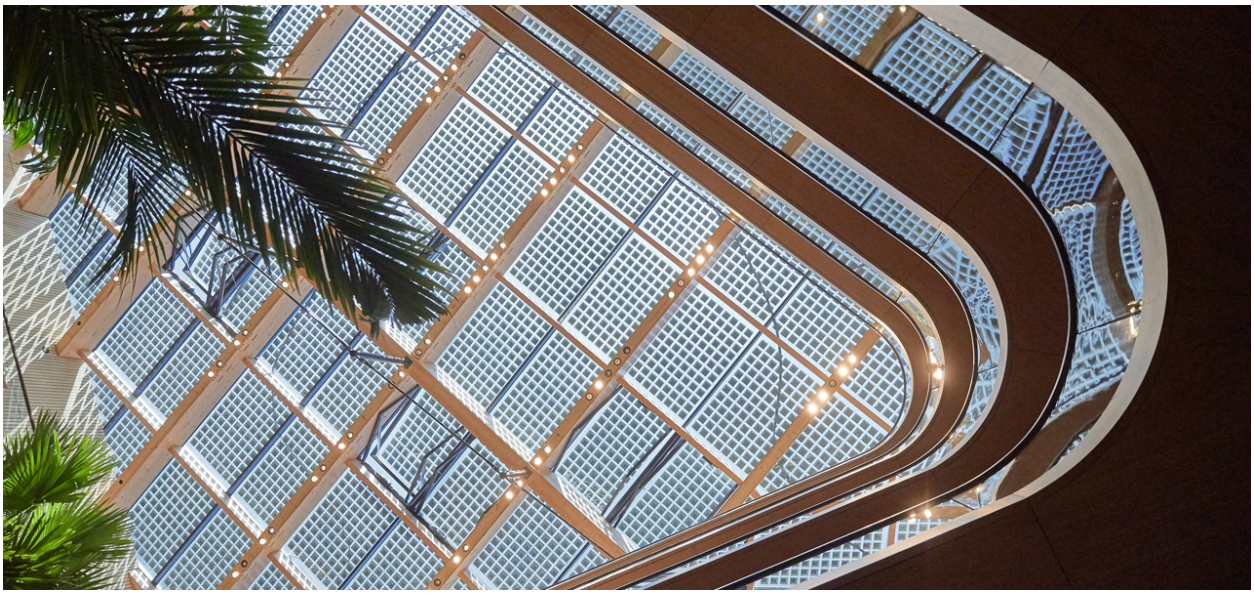
Figure 4.6: Building integrated PV cells (Hotel Jakarta, n.d.)

To prevent energy loss the building is highly insolated and makes use of a double façade to give guests access to a balcony and fresh air from their rooms. The double façade is insulated with triple glazing on the inside and an additional layer of glass at the outside of the balcony, with the ability to open or close both as wanted. The balcony also provides additional overhang, preventing direct sunlight into the room in summer months. Lastly, LED lights are used to reduce energy demand and prevent additional heating (M. Milius, personal communication, March 21, 2019). An overview of all energy features can be seen in appendix 6.

Water
The Hotel Jakarta opted for rainwater collection to water the plants in the atrium. By collecting rainwater from the roof, no additional freshwater is needed to maintain the atrium (P. Lesimanuaja, personal communication, November 21, 2018). Low-flow shower heads and toilettes are also used to reduce freshwater demand (M. Milius, personal communication, March 21, 2019).

4.2.4 Overall advantages

The biggest advantage that all of the sustainability efforts provided was winning the tender. By setting high ambitions to outperform the hotel sustainability menu provided by the city, and aiming for BREEAM Excellent certification, Westcord won the tender and was awarded the site for development (P. Lesimanuaja, personal communication, November 21, 2018). The BREEAM credits can be seen in appendix 3. This is an example of how the city can influence sustainable real estate development and circularity.

By striving for an energy neutral building, the end product is modeled to generate more PV energy than the building demands, saving money on energy bills and future proofing Hotel Jakarta from changing availability and prices of energy (M. Milius, personal communication, March 21, 2019).

Awards
2018 Architecten Web Public Building of the Year (Hotel Jakarta, n.d.)
2018 American Architecture Masterprize – architectural design/ green architecture (Hotel Jakarta, n.d.)

4.2.5 Overall challenges

When certifying the Hotel Jakarta to a BREEAM Excellent standard the design team needed to work closely with the Dutch Green Building Council, who administer the certification, to organize a bespoke certificate. Because this was a hotel project it did not fit under a standard BREEAM certificate and required a lot of cooperation between the certifying council and project team. The process of working on prefabricated hotel rooms was also a challenge. The prefabricated rooms need to be designed down to every detail much sooner than the rest of the hotel, forcing the project team to think in big and small scales simultaneously. Lastly, because of the unique design that incorporates extensive wood and the atrium space, the project was hard to fire regulate. This took cooperation and innovation between the design team and the city to find appropriate solutions (M. Milius, personal communication, March 21, 2019).

The additional costs for meeting the requirements of the BREEAM excellent certificate are estimated to be 2.5% above traditional building costs. Hotel Jakarta is still focused on how to improve in the future, by reducing waste and incorporating more initiatives (P. Lesimanuaja, personal communication, November 21, 2018).

4.2.5 Lessons learned

Minke Milius was responsible for the sustainability, acoustics and fire protection of Hotel Jakarta. After going through this project, she would now want to use a dynamic modeling software that would calculate heating and cooling days throughout the year and not just at one point in time. This would provide more accurate data for the energy use of the building. She also noticed that in such an innovative and ambitious project all collaborators need to be thinking in the same way – thinking ambitiously and innovatively (personal communication, March 21, 2019).

Tips for the next project: start for an optimal BREEAM score as early as possible at the BREEAM traject! (Hotel Jakarta, n.d.)

4.2.6 Overview

Table 4.2: Overview of data gathered through in-depth interview on Hotel Jakarta

	Hotel Jakarta
Contact	Pascal Lesimanuaja - Hotel Jakarta Bas Mastboom and Roman Griffijn - Building for Tomorrow Minke Milius - DGMR - Sustainability consultant
Drivers	Regulatory: City put forth a Sustainable Hotels Menu and asked for tenderers to at least reach silver or gold level. Hotel Jakarta wanted to do something more to win the tender, that is why they went for the BREEAM certificate. Tender/city required project to maintain goals for project
	Financial: City provided subsidy for BREEAM Certificate
Materials	FSC certified wood
	prefabricated modular rooms
	sustainable staff uniforms
	waste separation
	reuse waste to make soap
	bamboo to show extra commitment
	minimize finishing- all finishes to be complete when contractor leaves, savings on materials and time
	Minimal concrete used, 25-30% recycled when used
Energy	no air conditioning
	Energy neutral building
	underground thermal energy storage
	600m2 solar cells
	300m2 solar water heater
	PV cells on façade - give energy back to grid when not needed and take when needed
	PV on a distance - at the Fashion Hotel
	250m2 BIPV (building integrated photovoltaics) integrated into glass roof, also help to shade atrium below

	high insolation - RC>=10.5m2 on exterior facade, U<= .78w/m2 on roof, RC?7 for floor
	triple glazing to balcony and single glazing between balcony and outside
	benefit that occupants can open window for ventilation and cooling
	heat exchange WYW on shower
	indoor garden and atrium insulate building and absorb heat - act as heart and lungs of the building
	LED lighting in whole building - reduce energy demand and don't give off heat: 2.4w/m2 in hotel rooms, 3w/m2 in open space
	future plans for electric charging station, free bike rental, extra public transport organized to the site
	high insolation - RC>=10.5m2 on exterior facade, U<= .78w/m2 on roof, RC 7 for floor
	Warmtepomp WKO into Ij river
Water	rainwater collection for atrium plant watering
	low flow shower heads
	Low flow toilette
Overall Advantages	BREEAM excellent
	public building of the year
	American Architecture Masterprize -Architectural Design / Green Architecture
	bespoke BREEAM certificate for mix use space - lots of work with the DGBC required - design score 73%, pre-opening score 72%
	Reached all elements of gold duurzame menukaart hotels except 3 because they were considered non-advantageous
	Energy neutral - more PV than total energy demand
	low energy bills, future proof to changing energy availability and prices
Overall Challenges	BREEAM estimated to cost 2.5% more than traditional building
	how to improve in the future
	supply chain - how to change if not sustainable
	payback time not known
	Working with DGBC on special BREEAM certificate
	need to think early in the design process for prefabricated rooms - thinking big and small scale early on
	wood and atrium difficult to fire regulate
	discipline integration for BREEAM score
Lessons learned	now would use dynamic system modeling - software was not available at the time
	good collaboration needed between all parties to achieve high score - difficult for some parties to think ambitiously/innovatively

4.3 The case of Conscious Hotel Westerpark

Figure 4.8: Conscious Hotel Westerpark (Conscious Hotels, n.d.)

4.3.1 Introduction

Conscious Hotel Westerpark is one of four hotels in the Conscious group. Independently owned and operated the name announces the ambitions behind Conscious Hotels (Conscious Hotels, n.d.). They strive to be hip and sustainable without pushing it onto guests. The Westerpark location was redeveloped and opened in 2018 on the site of an old gas factory that had been remediated. The building itself was the former office and workshop of the factory. It is the first hotel in the Netherlands to run on 100% electricity, no gas, a special task given the history of the site. The Hotel has 89 rooms as well as a lobby and restaurant (Hylkema Erfgoed, 2018). Conscious Hotels aims to provide high quality accommodation while doing things consciously, "*We will cut back on our margins and have less profit"* (K. Heeringa, personal communication, February 13, 2019).

Development strategy

The Conscious Hotel Westerpark was redeveloped by Meyer Bergman for Conscious Hotels and the architect was Maarten Peek (Hylkema Erfgoed, 2018). The project had a bank loan but also revenue from other projects to put into this development (K. Heeringa, personal communication, February 13, 2019).

4.3.2 Motivations for circularity

Conscious Hotels does not intend to be circular, but the brand does intend to be conscious about everything they do. Conscious was started by two men, Marco and Sam, who had a background in hotel consulting. They decided it would be more fun to have their own hotel and after one had the birth of a

daughter, the pair decided to make hotels that contributed to a better future. Since then they have opened four hotels, all in redeveloped iconic buildings in Amsterdam. The Westerpark is owned by a private party that wanted to redevelop the old gas factory site in a sustainable way. This made Conscious a good partner for the hotel property. When applying for the tender for this hotel location, Conscious Hotels explained their vision for social and environmental good. This led them to win the tender and gain access to the site. The drive for all of the social and environmental initiatives they have implemented have been intrinsic (K. Heeringa, personal communication, February 13, 2019).

4.3.3 Circularity initiatives implemented

Materials

The Conscious Hotel Westerpark is housed in an old office building. By redeveloping an old building for a new purpose, the building gives a second life to the materials already in use. On the operational side, all rooms are fitted out with Auping circular mattresses designed to 100% recycled and reused in products of similar or higher grade. The kitchen focuses on using organic food and drinks and collects coffee grounds to be reused in soap production. The kitchen also composts organic waste. All waste is separated and recycled as with the city needed (K. Heeringa, personal communication, February 13, 2019).

Energy

The Conscious Hotel Westerpark is the first 100% electric hotel in the Netherlands. Making use of a geothermal heating system for all heating and cooling. When the rooms are not occupied they are controlled to use less energy. The building is divided into thermal compartments to adjust the climate separately and minimize energy use. All energy comes from a Raedt Huys, a green energy supplier that supplies wind energy (K. Heeringa, personal communication, February 13, 2019).

Water

Low flow showerheads and taps are used to reduce water use. In the future Conscious Hotel Westerpark will collect rainwater in to water the front garden (K. Heeringa, personal communication, February 13, 2019).

4.3.4 Overall advantages

Conscious Hotel Westerpark is Green Key Gold certified hotel. Green Key is a voluntary certification representing a commitment by businesses to set environmental standards. Because of the commitments to their mission employees actively seek out jobs at Concious. Founders Marcus and Sam were named Best Entrepreneurs by Entrée Magazine in 2018. This brought a lot of publicity and an influx of guests. For now, it is measured that about 20% of guests come to Conscious specifically for the brand. Additionally, they have many corporate contracts looking for a lodging destination in line with their own missions (K. Heeringa, personal communication, February 13, 2019).

4.3.5 Overall challenges

The most challenging part of the conscious approach is finding partners that are willing to do things the conscious way. Designers are often pushing for cheaper products and Conscious has to remind them that that is not the goal. This also includes finding sustainable or certified suppliers. Managers are very autonomous to make their own decisions regarding food and beverage or other procurement products but it isn't always easy. Consciously selecting products is not cheaper than traditional products but the hotel takes smaller margins to make these accessible for guests (K. Heeringa, personal communication, February 13, 2019).

4.3.7 Overview

Table 4.3: Overview of data gathered through in-depth interview on Conscious Hotel

	Conscious Hotels
Contact	Karen Heeringa - Conscious Hotels
Drivers	Internal: Founders desire to make better hotels for future generation
	Required by owners of the land - new development must be sustainable
Materials	Building re-use
	Cradle to cradle carpets from Desso
	Circular bed and mattress concept with Auping
	Organic food and drinks
	compost
	reuse coffee to make soap
	separate waste and use city recycling for large materials
Energy	No AC - air treatment mechanism instead
	Solar panels
	No gas
	Raedt Huys energy provider of wind energy and green gas
	High insulation foil on double glazed windows
Water	Low flow showers and taps
	Sensors for tap flow
	To collect rainwater in the future
Overall Advantages	Green Key Gold Certified
	best entrepreneurs award from Entrée Magazine - brings publicity and guests
	20% of guests choose for the hotel because of its mission statement
	many corporate clients choose it because it is in line with their mission
	Staff comes to Conscious because of the mission statement - many students in sustainability field
	occupancy rate of 85%
Overall Challenges	finding sustainable and certified products - managers are very autonomous and can make their own decisions as long as they fit in these guidelines
	hiring contractors that do things in the Conscious way
	more expensive but take smaller margins than traditional hotels

4.4 Cross case analysis

From the three case studies presented in chapter 4 a wide variety of circularity implementations have been identified. Additionally, the motivations, advantages and challenges of doing so have also been presented. These will be analyzed further. Table 4.4 provides an overview of circularity initiatives discovered during case studies, organized by resource flow and building layer, as proposed by Brand (1994).

Table 4.4: Overview of circularity initiatives gathered from case studies, organized by building layer

Building layer	Flow	Initiative
Stuff: 1-5years	Materials	Reuse fruit waste to make soap
		Give coffee grounds to mushroom farmers as fertilizer
		Greenhouse on roof - produces 4% of restaurant's food by weight and fish when possible
		Pre-cast concrete used a lot
		Minimize kitchen waste
		Service filtered tap water in reusable bottles - Madeblue
		Minimize construction waste
		Waste separation
		Circular bed and mattress concept with Auping
		Compost organic waste
	Energy	

	Water	
Space plan: 10 years	Materials	Circular carpeting (Interface) (Desso)
		Wood locally sourced in France and oil used to stain instead of lacquer
		Investing in long lasting materials - designed to be reused - break up into layers of components
		FSC certified wood/ Bamboo
		Minimize finishings
	Energy	
	Water	
Services: 25 years	Materials	
	Energy	Aquifer thermal energy storage
		Geothermal heating and cooling system into Ij river
		PV cells on the roof
		Solar water heater on roof
		PV cells on façade
		PV on a distance
		Building integrated photovoltaics
		Heat exchange on shower
		LED lighting
	Water	Greywater system from shower and sinks in guestrooms reused in the toilettes
		Low flow taps
		OZONE water used to clean rooms without chemicals
		Rainwater collection for atrium plant watering
		Sensors for tap flow
Skin: 50 years	Materials	
	Energy	Intelligent façade
		High insulation foil on double glazed windows
	Water	
Structure: 100 years	Materials	Building designed to be repurposed
		30% recycled concrete used
		Prefabricated modular rooms
		FSC certified wood/ bamboo
	Energy	High insolation on façade roof and floor
		Climate balcony: triple glazing to balcony and single glazing between balcony and outside
		Operable windows
		Greenhouse atrium as a thermal buffer: pre-heating in the winter leaf and water evaporation cooling in the summer
	Water	
Site: Infinite	Materials	
	Energy	
	Water	

4.4.1 Practical cases of circularity in hotel buildings and operations

It is important to note that the QO Hotel was the only hotel developed from the start with circularity in mind. This allowed the developer to actively incorporate circularity into the materials, energy and water systems of the building. Hotel Jakarta and Conscious Hotels had goals for sustainability and the initiatives they incorporated also contribute towards circular hotel buildings and operations as defined in chapter 3. An overview of all circularity initiatives was provided for each case study.

4.4.2 Motivations

The motivations of the case hotels to incorporate circularity can be divided into three categories: (1) intrinsic (2) regulatory (3) financial.

Intrinsic

In the case of QO Hotel and Conscious Hotel intrinsic motivations led them to select circularity initiatives. Both were led by innovative entrepreneurs that wanted to do something different from the status quo. The motivations of the QO Hotel were mostly environmental, to be the most sustainable hotel. The motivations of the Conscious Hotels were more social, to create a better hotel product for future generations. These intrinsic motivations shape the decisions behind these projects and also the brand identity.

Regulatory

Each of the three case studies were required by some regulatory body to have a certain level of sustainability. Besides complying with the EPBD regulations in the Netherlands for energy efficiency, each project was motivated by additional regulations. For the Hotel Jakarta the guidelines were very clearly set forth by the city of Amsterdam in the Sustainable Hotels Menu. For Conscious Hotel the owners of the entire park required that all development within the park be at a sustainable level, from the information gathered in the in-depth interview there was no specific sustainability requirements laid out. The interviews and documentation from the QO Hotel did not state explicit sustainability requirements either and emphasized the intrinsic motivations behind the circularity initiatives.

Financial

The Hotel Jakarta was given a subsidy by the City of Amsterdam for their BREEAM excellent certificate. This motivated the Hotel Jakarta to achieve nothing less than excellent certification. The amount of the subsidy was not disclosed through the case studies. The QO Hotel did not implement any initiatives because of financial reasons but more to reduce risk. Amstelside recognizes that banks are increasingly looking to sustainability a requirement for a bank loan. They also see it as a risk to not future proof the building for future accommodation requirements. Conscious Hotels did not reveal any financial incentives for their circularity initiatives, and in fact pointed to increase in costs and decrease in profit margins for such measures.

4.4.3 Advantages

Certifications

Each of the case studies has one or more certifications to recognize their efforts in sustainability. Each certification focuses on different aspects of the building, operations or management. As Xander Bueno de Mesquita said of the QO Hotel, “go from your own strength and then look at the certifications which would make sense” (personal communication, January 23, 2019). That is why the QO Hotel went for LEED certification, it was viewed as the most flexible and rewarding to innovation. From the management company, IHG, they were also required to obtain a Green Globe certification. Hotel Jakarta selected the BREEAM certificate, which is more common than LEED within the Netherlands and administered by the

Dutch Green Building Council. Conscious Hotel did not apply for a building certification and instead is Green Key Gold certified, which focuses on management and operations.

Awards

All three case studies have won awards based on their innovative and sustainable buildings. The QO and Hotel Jakarta have won multiple awards because of the building design and sustainability while Conscious Hotels was awarded for their forward-thinking leadership. Conscious was able to identify an increase in publicity and business from this recognition.

4.4.4 Challenges

Partners

All three case studies revealed challenges in finding partners who shared the same vision for sustainability or circularity and products available on the market. The QO Hotel expressed frustration with finding development partners who understood the vision and could speak about innovation in hotel buildings. The Hotel Jakarta expressed difficulties in establishing a sustainable supply chain. Conscious Hotel experienced challenges finding design partners that could think with them when selecting products. This challenge is one that the Circular Hotels Leaders Group is working to fix by establishing collective bargaining power with suppliers and creating central resources for hotels (CREM, 2018).

Financial

Each interviewee was asked about the financial costs and savings associated with the sustainability and circularity initiatives they implemented. Hotel Jakarta was able to estimate that the measures required for the BREEAM certificate cost 2.5% more than a traditional building. Others were not able to provide concrete cost or savings information about any of the initiatives implemented. This leaves room for further investigation into the value (costs and benefits) of circularity initiatives in hotel buildings and operations.

4.5 Conclusion

The circular initiatives that have been implemented in the case studies range in building layer and category of circularity. This shows that there are many examples already being put into practice, an overview of which can be seen in table 4.4. Additionally, the motivations advantages and challenges were presented. If a hotel does not have intrinsic motivations to incorporate circularity it is also important to analyze the regulatory and financial landscape. Local regulations should be analyzed as well as any financial incentives or risks involved. Advantages include certifications, subsidies, future-proofing to changing landscape and awards that increase visibility. Challenges include finding partners and suppliers to fulfill a sustainable or circular mission. The value of these circularity initiatives is still mostly unknown.

5 Findings and lessons learned

This chapter is used to understand and compare findings from theory and empirical findings. First, the findings from theory and practice are compared using a table design as suggested by Eisenhardt (1989). The table comparison helps to see patterns of similarities and differences across the topic. Additionally, for each topic analyzed between theory and practice a lesson is drawn. These lessons will later be validated through the validation case and the expert panel, described in chapter 6.

5.1 Theory vs practice

Theory vs practice intends to clearly state the outcomes of the literature review next to the empirical findings from case studies. The main similarities and differences are identified and explained. The categories compared are based on the conceptual framework from section 1.7. Findings from theory and from case studies are compared using a table and graphic representation as used by de Blok (2018). An overview of findings can be seen in tables 5.2, 5.3, 5.4, and 5.5. The legend explaining the graphic symbols used in the comparison tables can be seen in table 5.1.

Table 5.1: Explanation of symbols in section 5

Theory	Empirical findings
✓ Aspect was found in empirical findings	= Corresponding to existing theories
X Aspect was not found in empirical findings	+ New aspect compared to the existing theories

5.1.1 Motivations

Through the literature review it was found that hotels have been motivated for circularity in two different ways: through regulation or intrinsically. Two forms of regulation were identified. First, on a national level the EPBD currently requires all office buildings to have an energy label C by 2023 and A by 2030 (RVO, n.d.) This is expected to extend to hotel buildings in the future (JLL, 2018). Also, on a national level, the Dutch government laid out a vision for "A Circular Economy in the Netherlands by 2050" with objectives for the construction industry. The vision does not currently have regulatory implications but illustrated the direction that the government is headed. On the local level, the City of Amsterdam has used regulation to direct new development. Through tender requirements the City dictated a certain level of sustainability, which has led to the implementation of circularity initiatives in the Hotel Jakarta. Without reaching the desired level of sustainability Hotel Jakarta would not have won the tender in the first place.

The Circular Hotels Leaders Group in Amsterdam is a volunteer collaboration between hotels to incorporate circularity into their operations. They are participating in this group for intrinsic reasons with the goal of improving processes and reducing environmental impact (CREM, 2018). Specifically, Conscious Hotels is motivated for sustainability and to participate in the Circular Hotels Leaders Group because of the founder's desire to find a positive alternative to traditional hotels. Additionally, Ambassade Hotel is motivated by their interest to maintain the community they are a part of. An overview of the theory and empirical findings can be found in table 5.2.

5.1.2 Lessons learned on motivations

Hoteliers are motivated to implement circularity initiatives in buildings and operations for regulatory and intrinsic reasons.

Table 5.2: Theory vs empirical findings: motivations

	Theory	Empirical findings
Motivations	✓ Regulatory ✓ Intrinsic	= Regulatory = Intrinsic + Financial

5.1.3 Circular resource flows

Literature identified three resource flows that are important to consider when looking at building circularity. They were materials, energy and water. The definition of a circular economy by the Ellen MacArthur Foundation is based off of four forms of value creation from the reduction and reuse of materials (Ellen MacArthur Foundation, 2013). In the Dutch vision for "A Circular Economy in the Netherlands by 2050" the government identifies four ways for the construction industry to be more circular, including two recommendations for materials and one for a reduction in CO2 emissions, which can be achieved through a change in energy demand or generation (Ministry of IE I&M EA., 2016). Furthermore, in the framework for circular buildings proposed by the Dutch Green Building Council includes 7 areas to consider in circular buildings. Three of which consider resources at the building level (Kubbinga et al., 2018, pg. 12):

1. Materials are incorporated into the economy in such a way that they can be cycled at continuous high value
2. All energy is based on renewable sources
3. Water is managed in 100% circular fashion

Additionally, Van Odijk and Van Bovene (2015) propose what the construction industry needs to consider when transitioning from a linear to circular sector. They highlight the impact of electricity, heating and water use, along with the optimization and reuse of buildings, and designing for disassembly, re-use and adaptability. Furthermore, Rau (et al., 2016) illustrates the importance of materials in building. By giving all materials an identity, waste from one project can become material for another. The circular resource flows identified in literature are materials, energy and water.

Empirical findings can also be categorized into these three categories, with the addition of waste. All case studies provided information about circular initiatives they implemented related to materials, energy and water. This could also be because the questions asked in the case studies pertained to these three resource flows. Case study research found that waste was an additional resource flow to be considered. Each case provided examples of things they were doing to reduce or reuse waste in an effort to be more circular. Based on the information collected in the literature review, the researcher recategorized initiatives that case studies identified as waste, into either materials, energy or water.

Empirical results for material initiatives included aims to reduce material use, reuse materials, and recycle materials. The 9R framework (PBL, 2016) shows that reducing material use is the most circular technique, being followed by reusing materials and in the worst-case scenario recycling them. All of these options are better than the construction waste that makes up 40% of the Dutch waste stream (Ministry of IE I&M EA., 2016).

Energy initiatives found in empirical case studies included methods to reduce energy demand through high insulation and efficient lighting. Energy generating initiatives were also found, such as geothermal

heating systems and multiple examples of ways to use PV panels. Energy is even reused through heat exchange systems on showers and from return air. Initiatives in water were uncovered in the services of hotel buildings. Water was reduced through low flow taps and sensors to stop tap flow when it is no longer needed. Water is recycled and reused through greywater systems and the collection of rainwater for use of plant watering.

For this research the waste initiatives have been recategorized into the previous three categories. They were presented as their own resource flows. Specific waste initiatives found included recycling concrete for use in new buildings and diverting organic waste from landfills. An overview of circular resource flows in buildings and empirical findings can be seen in table 5.3.

5.1.4 Lessons learned on circular resource flows in real estate

Circular real estate concerns the resource flows of materials, energy and water as concluded from theory. Empirical research also included waste as an important resource flow to consider. For this research initiatives in circular waste management will be included in the category of resources that they are managing, either materials energy or water. One example of a circular waste initiative mentioned was using recycled concrete to not create waste from a demolished building and to save energy from not producing new concrete. This initiative can be included in material circularity because it also concerns the reuse of a material. Another initiative was collecting and reusing fruit peels to make soap. This does divert the peels from the waste stream but also reduces the materials needed to make soap, therefore it has been included as a material initiative. Based on theoretical and empirical results, this research will continue categorizing circularity initiatives in the categories of materials, energy and water.

Table 5.3: Theory vs empirical findings: circular resource flows in buildings

	Theory	Empirical findings
Circular resource flows in real estate	✓ Materials ✓ Energy ✓ Water	= Materials = Energy = Water + Waste

5.1.5 Advantages

Literature showed that sustainable hotels enjoy some advantages such as building or operational certifications, additional revenues from guests who are willing to pay more for a more sustainable hotel, a competitive advantage in attracting sustainably minded guests and limiting risks of future legislation and resource availability. While empirical findings found that hotels were able to obtain a certificate for their green building or operational practices, they were not able to put a value on the certification or measure their competitive advantage in higher room prices or more guest stays. They did note an advantage when it came to hiring and retaining employees who were interested in working for a company with a sustainable focus. Furthermore, all three case studies benefited by winning awards due to their focus on sustainability or circularity. An overview of all advantages from theory and empirical findings can be found in table 5.4.

5.1.6 Lessons learned on advantages

The advantages of implementing circularity in hotel buildings and operations are green building certifications and gaining a competitive advantage. Additional advantages include a reduced environmental impact, reduced shadow costs, additional revenues, limit risks and winning awards.

Table 5.4: Theory vs empirical findings: advantages

	Theory	Empirical findings
Advantages	✓ Certifications ✓ Competitive advantage X Reduce environmental impact X Reduce shadow costs X Additional revenues X Limit risk	= Certifications = Competitive advantage + Awards

5.1.7 Challenges

The literature review revealed some challenges to hotels that have incorporated circularity into their buildings and operations. From members of the Circular Hotels Leaders Group it was identified that while they have implemented many initiatives the benefits remain unclear. The members felt that they were unable to link revenues to circularity initiatives or measure the additional costs/savings they were experiencing (W. Broer, personal communication, 22 November, 2018). This challenge was echoed in the empirical findings. All three cases implemented circularity initiatives but were not able to quantify energy or water savings or link their efforts to additional revenue. Hotel Jakarta plans to quantify this information in the future but is still gathering data, as the hotel recently opened.

Also found in theory and empirically was the desire to do more. Theory showed that hotels in the Circular Hotels Leaders Group wanted to make sure they were going beyond regulations and working towards circularity. This was also seen through empirical case studies in which hotels that were already going quite a lot on sustainability were looking to do more and understand how they too can move towards circularity.

An additional challenge found in theory and through case studies is that national government and legislation is running behind ambitions of hotels and that more could be done to support and encourage them. One example was explained at Hotel Jakarta. They had a difficult time fire regulating the wooden atrium that was part of the thermal concept and design decision to minimize interior finishes. The sustainability consultant had to convince regulators that this untraditional design would still meet the needs of fire regulations (M. Milius, personal communication, March 21, 2019).

Additional challenges identified through case studies include financial challenges and the ability to find the right partners. The Hotel Jakarta estimates that they needed to put in an additional 2.5% of investment to obtain the desired BREEAM score compared to having no BREEAM certificate and that the payback times for this investment is not known (P. Lesimanuaja, personal communication, November 21, 2018). The other challenge that came up in all case studies was the ability to find partners at every stage of the project to work towards circularity. In the design phase the developers of The QO hotel had a hard time finding an architect willing to be innovative with them (X. Bueno de Mesquita, personal communication, January 23, 2019). Hotel Jakarta and Conscious hotel both expressed having a hard time finding suppliers who can provide products that meet their circularity ambitions, and an interest in working with suppliers who could meet their needs.

Another challenge found through empirical research is that hotel guests use a lot of resources. While the case studies of the QO and Hotel Jakarta have built sustainable buildings, they do not want to restrict their guests' behaviors, leading to longer than predicted showers and more energy used than expected (J. Zeeman, personal communication, February 5, 2019). Despite all of the technology in the hotels, changing user behavior is an additional challenge for these sustainable hotels. Finally, due to the larger

than usual IT installations that are necessary to run the technologies in the hotels, the QO Hotel stated that they are also challenged with high IT costs (J. Zeeman, personal communication, February 5, 2019). An overview of all challenges from theory and empirical findings can be seen in table 5.5.

5.1.8 Lessons learned on challenges

Challenges to implementing circularity in hotel buildings and operations include unclear benefits, a desire to always do more and regulations running behind private ambitions. Additional challenges include finding partners, user behavior, high IT costs and high investment costs.

Table 5.5: Theory vs empirical findings: challenges

	Theory	Empirical findings
Challenges	✓ Benefits unclear ✓ How to do more ✓ Regulation running behind	= Benefits unclear = How to do more = Regulation running behind + Partners + User behavior + High IT costs + Financial

6 Validating findings with The Student Hotel

The aim of this chapter is to validate findings through concrete examples of circularity in hotel buildings and operations through the case of TSH. This begins with an understanding of circularity at TSH. This case study is based on a research internship at TSH. TSH demonstrated an interest in exploring circularity initiatives and therefore became a compatible research partner for this project. The case of TSH will investigate the companies broader CSR ambitions and specific ambitions for circularity in real estate.

This chapter will answer sub-question 5:

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5. How is a circular implementation different from a traditional implementation?

In order to answer these questions semi-structured interviews were conducted with employees of TSH and Innovation Lighthouse. Innovation Lighthouse is a living lab for testing innovations and measuring their impact in the built environment. The list of interviewees can be found in appendix 2. Additionally, meetings were held with circularity consultants of TSH including 172Impact, DSM and Phi Factory.

6.1 About TSH

"We create the best space, so that people can discover their purpose and go change the world." (mission statement TSH, n.d.)

TSH is a completely connected community of students, travelers, mobile professionals, creative nomads and enterprisers. A network of 12 hotels throughout Europe provide co-living and co-working spaces for students and professionals. Hotels consist of, "fully-equipped rooms and studios, kitchens (shared or private), flexible co-working space, chill out lounges, libraries, TedTalks booths, ping pong tables, gyms, all-day dining restaurants, designer bikes, laundry facilities, meeting rooms, auditoriums, calendar of events, swimming pools (select locations), shared common facilities and extensive ground floors where people can come together. And the beating heart of each of our hotels: our melting pot, student-for-life community." (TSH, n.d.)

Founded in The Netherlands 2008 by Scottish entrepreneur Charlie MacGregor, TSH now develops, owns and operates hotels in the Netherlands, Spain, Germany, Italy, and France. A future 11 hotels are planned to open in the coming 3 years (TSH, n.d.) The business model is based on a hybrid concept of semester long student housing, short stay housing and hotel rooms as seen in figure 6.1.

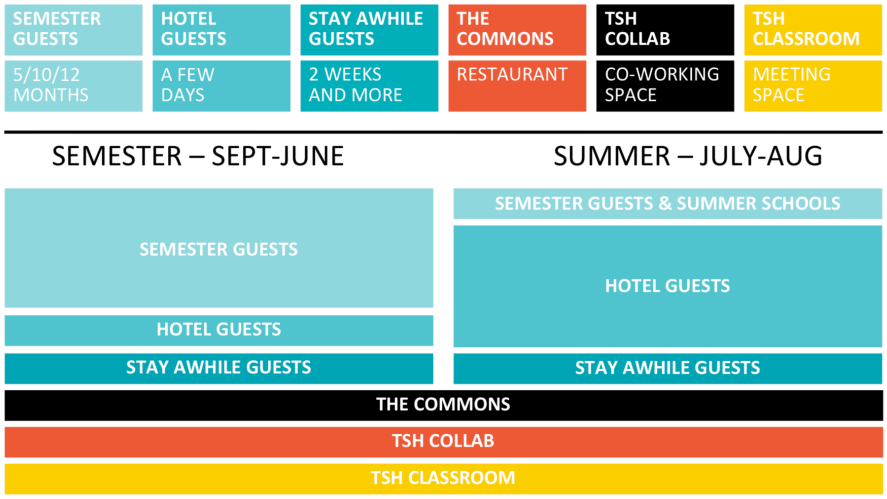

Figure 6.1: TSH product offering (TSH, 2019b)

6.1.1 Motivations for sustainability at TSH

TSH aims to devote 10% of its resources, skills love, energy and square meters to change the world and make a positive impact. To manage this, TSH employs an Impact Manager. The Impact Manager is responsible for TSH's corporate social responsibility (CSR) strategy and implementation. CSR refers to the voluntary activity of a company to pursue goals that are beneficial for society beyond those required by government legislation (Dahlsrud, 2008).

The TSH CSR strategy is structured around the 6 pillars explained in chapter 1. Because this research is focused on circularity in real estate, it is concerned with the "greening our buildings" pillar. TSH recognizes the impact that their business has on the environment and has chosen to invest in sustainability in their buildings and operations. All buildings are certified with at least a BREEAM Good certificate, and some with a Very Good or Excellent certification. Additionally, TSH has installed energy meters in buildings and software that helps to track and optimize energy usage (Westerborg, 2019).

TSH has recently independently joined GRESB. GRESB is a benchmarking tool to measure environmental, social and governance (ESG) performance against the industry. Previously, TSH reported to GRESB within an investor's portfolio, but from 2019 on will be reporting and benchmarking assets independently. The goal is for improving performance year on year (Westerborg, 2019). After completing data reporting, TSH will receive a report on where they stand against peers and a roadmap to improve on ESG performance. Many investors use GRESB to measure and improve the sustainability performance of their entire real estate portfolio by engaging with managers and demanding increasingly strict ESG requirements (GRESB, 2019).

6.1.2 TSH real estate

At the heart of TSH is its real estate. TSH currently has 12 hotels open with 11 under development and many more in the pipeline. The current and future hotels are a mix of new and redeveloped buildings. From 2008 to 2014 hotels were developed in the Netherlands to test the concept. In 2014 the Amsterdam City location was opened as the first hotel built with the full suite of TSH offerings, including The Commons restaurant, The Collab co-working space and The Classroom meeting space. Figure 5.2 shows the previous and expected growth in hotel rooms. Figure 5.3 shows the future expansion plans for TSH.

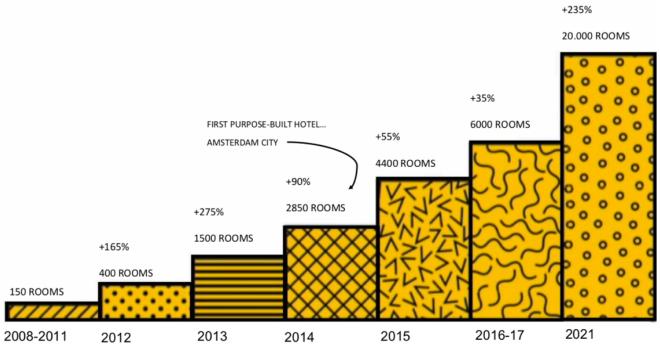

Figure 6.2: Hotel openings (TSH, 2018b)

Figure 6.3: TSH global network (TSH, 2018b)

As TSH expands across Europe and the concept has proven successful, it is the responsibility of the real estate team to select appropriate sites. Choices made by the real estate team in the sourcing and development stages have a direct effect on the operations team during the open and maintain stages. The TSH Property Life Cycle is shown in figure 6.4.

Figure 6.4: TSH Property Life Cycle (TSH, 2018b)

TSH owns, develops, maintains and operates all of their own properties. This allows the real estate team to work closely with the operations team to understand their needs when developing a new hotel (M. Çatalgöl, personal communication, March 5, 2019). At TSH the real estate is highly intertwined with the

brand, because the product is the hotel. This means that any business strategy decision would also affect real estate decisions and operational decisions and are made within one management team, see figure 6.5. For example, TSH targets the student market, therefore all real estate developments are located in cities with big student populations. Additionally, the business strategy is to offer a certain aesthetic, to guests, the real estate and design team then implements the strategy. These strategic decisions are made by one management team, and the real estate team then follows and accommodates the business strategy. The same is true for the business strategy to become a circular hotel.

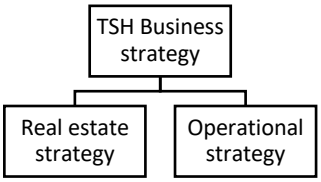

Figure 6.5: Hierarchy of decision making at TSH (own illustration)

6.1.3 Circularity at TSH

TSH has an ambition to decrease the impact on the environment from their hotels by increasing the circularity of their real estate. To do this, TSH has begun investigating how to incorporate circularity into their buildings and operations. Current projects include a circular first floor fit out for the hotel currently being developed in Delft, research into mattress alternatives, circular furniture and reusing fabrics lefts behind by students.

"With our fast-growing portfolio we've got an opportunity to have a lasting impact across the world, and we're trying to make the most of it" (TSH, n.d.)

TSH developed a framework for implementing circularity into the Delft project, the ambition titled "TSH Delft goes circular!" can be found in appendix 5. TSH has adopted the definition of the circularity provided by the Ellen MacArthur foundation as:

The aim should be to create a system that allows for the long life, optimal reuse, refurbishment, remanufacturing and recycling of products and materials (2016)

After gaining this understanding of circularity, TSH developed their own working definition on circular economy:

"Circularity for TSH Delft represents a hotel that is designed for longevity, re-use and recovery of materials and products, and where these elements are added to the definition of value, without losing the TSH Brand Identity of well-designed spaces and optimal guest experience. "

More simply:

"a hotel that is designed for longevity, re-use and recovery of materials and products"

While TSH understands it is not realistic to meet all of the design principles of circularity, they challenge their designers, engineers and procurements teams to quantifiably commit to at least one of them, such as:

Design principle	Indicator
Longevity	○ Desired Life span in years ○ Usable life span in years ○ Ease of maintenance / repair
Re-use	○ After life purpose ○ Standardization
Recovery	○ Disassembly (%) ○ Modularity

Because TSH develops, owns and operates their own buildings they can benefit from long term investments in circularity. As their circular ambition states, "We're in it for the long run, hence all different departments should be at the table to achieve this new definition of value." Value should consider:

Value
Total Cost of Ownership
End of life value
Products as a service
De-risking operation though long-time partnerships

While TSH is working towards a circular fit out in Delft, they also have a strong brand identity they want to maintain. They feel that a circular hotel shouldn't have its own look and feel. "Our ambition should be that guests know that they're in a circular hotel, without actually seeing it.".

TSH Brand
Optimal guest experience
Well-designed spaces
Deliver a positive impact on the world

6.1.4 Motivations

In line with what was found in literature and through case studies, TSH is motivated internally to implement circularity. TSH has stated an internal desire to land in Delft with an innovative product, including a circular first floor fit out. TSH feels that providing a product with a focus on sustainability and innovation will also add commercial value to their product if it wants to be successful in a city with a leading technical university. Another motivation specifically for TSH Delft is to be a test lab for future developments (M, Çatalgöl, personal communication, 2 May, 2019).

6.1.5 Advantages

While TSH Delft is in the beginning of building phase, some advantages of their circularity efforts have already been seen. By setting goals for circularity the design and development teams have been open to looking for circular alternatives. TSH also perceives an advantage in investing now in circularity with the hopes of future-proofing their portfolio and benefiting later on.

6.1.6 Challenges

All challenges of circularity are not yet known to TSH because it has not yet been implemented. The Delft project is in the development stages. The challenges so far have been:

-defining circularity internally
-finding suitable partners
-investment strategy
-communicating and implementing a clear strategic goal
-finding a consensus between all internal operational stakeholders

Defining circularity internally
As described above, TSH has a working definition of circularity and a vision for a circular hotel. When selecting products there is an internal discussion about what is more circular, products that come from reused materials or products that are able to be reused at the end of life. Oliva Finch of The Ellen MacArthur Foundation (personal communication, March 20, 2019) recommended not to pause too long on these hurdles, but to select what works best for our situation and know that TSH cannot become fully circular overnight, any step in the right direction is an improvement.

Finding suitable partners
Similar to what was described in case studies, TSH has had challenges finding partners that can support and match their ambitions. Some consultants have been brought on board to advise decision making such as 172 Impact. Additional partners such as Phi Factory have been advising on specific product workshops. While these partners have assisted TSH in reaching their circularity goals, other partners such as the external interior designer have not met the expectations set by TSH. This requires TSH employees to do additional tasks.

Investment strategy
The business case for a new hotel dictates a set timeframe for when an investment should be paid-back. Current investment periods are shorter than the payback periods of most circular initiatives. This makes it difficult to make implementing initiatives financially attractive.

Communicating and implementing a clear strategy
As a company, TSH is involved in hotel design, development and operations. This requires many teams with many functions working simultaneously to reach a common goal. The goal for circularity has been stated by management and each team lead has been working on how to incorporate circularity into their team's work. This has led to a variety of circularity initiatives being carried out by different teams inconsistently.

6.2 Implementing circular initiatives at TSH
As described above, TSH is working on a circular first floor fit out for a new hotel development in Delft. A working definition of circularity at TSH has been developed and a vision has been written, it can be found in appendix 5. This section will use the circularity initiatives and lessons learned from the case studies to further develop three cases for implementing circularity in TSH Delft. These cases will be used during the expert panels to discuss alternatives in materials, energy and water.

6.2.1 Selecting circularity initiatives
Using the conceptual model shown in figure 1.2 this section will investigate circularity initiatives to implement at TSH Delft. One initiative from each of the categories of circularity will be investigated. The three categories were: materials, energy and water.

Following the conceptual model, the circularity initiatives are grouped by resource flow (material, energy or water) as well as building layer, as described in section 3.3.2. Based on the circularity ambitions of TSH

and the interest to maintain brand identify, some initiatives were selected for further study. The overview of circularity initiatives can be seen in table 6.1. The initiatives in bold have been selected in partnership with Melike Çatalgöl, TSH development manager, as potential for further study and use in the test case at TSH Delft.

Table 6.1: Overview of selected circularity initiatives for further investigation

Building layer	Flow	Initiative
Stuff: 1-5years	Materials	**Reuse fruit waste to make soap**
		Give coffee grounds to mushroom farmers as fertilizer
		Greenhouse on roof - produces 4% of restaurant's food by weight and fish when possible
		Pre-cast concrete used a lot
		Minimize kitchen waste
		Service filtered tap water in reusable bottles - Madeblue
		Minimize construction waste
		Waste separation
		Circular bed and mattress concept with Auping
		Compost organic waste
	Energy	
	Water	
Space plan: 10 years	Materials	**Circular carpeting (Interface) (Desso)**
		Wood locally sourced in France and oil used to stain instead of lacquer
		Investing in long lasting materials - designed to be reused - break up into layers of components
		FSC certified wood/ Bamboo
		Minimize finishings
	Energy	
	Water	
Services: 25 years	Materials	
	Energy	**Energy neutral building**
		Aquifer thermal energy storage
		Geothermal heating and cooling system into Ij river
		PV cells on the roof
		Solar water heater on roof
		PV cells on façade
		PV on a distance
		Building integrated photovoltaics
		Heat exchange on shower
		LED lighting
	Water	Greywater system from shower and sinks in guestrooms reused in the toilettes
		Low flow taps
		OZONE water used to clean rooms without chemicals
		Rainwater collection for atrium plant watering
		Sensors for tap flow
Skin: 50 years	Materials	
	Energy	**Intelligent façade**
		High insulation foil on double glazed windows
	Water	
Structure: 100 years	Materials	Building designed to be repurposed
		30% recycled concrete used
		Prefabricated modular rooms
		FSC certified wood/ bamboo
	Energy	**High insolation on façade roof and floor**
		Climate balcony: triple glazing to balcony and single glazing between balcony and outside
		Operable windows
		Greenhouse atrium as a thermal buffer: pre-heating in the winter leaf and water evaporation cooling in the summer
	Water	
Site: Infinite	Materials	
	Energy	

	Water	

This list was narrowed down to three initiatives for further investigation for implementation into TSH Delft. Initiatives were selected because they (1) were seen in practice through case study examples (2) represent the implementations necessary to transition the built environment to a circular one as defined by theory (3) were considered in collaboration with Melike Çatalgöl, TSH development manager on the feasibility and potential for analysis of implementation in TSH Delft. The following three initiatives were selected:

Table 6.2: Selected circularity initiatives for further investigation

Resource flow	Circularity initiative	Goal: gather strategic and operational considerations for implementing:
Materials	Flooring options	Circular flooring
Energy	Energy neutral building	Energy neutral building
Water	Rainwater collection and reuse	Rainwater collection and reuse

6.2.3 Circular materials

The Dutch Green Building Council describes material use in a circular building to be, “incorporated into the economy in such a way that they can be cycled at continuous high value” (Kubbinga et al., 2018). To improve upon the circularity of materials at TSH an investigation is done into the application and value of circular flooring at TSH Delft. For this study, a comparison was made between the currently used flooring material and potential alternatives, looking for options that provide the most circular solution.

When selecting a flooring multiple stakeholders from different teams are involved including: development, design, operations, and finance. Their concerns include: aesthetics, pricing, maintenance and durability. The current material used in TSH first floor fit outs is Bolidtop 525 poured resin flooring. The poured resin flooring is scratch resistant making it suitable to heavy traffic and greatly absorbs contact noise. The Bolidtop 525 flooring will be used as the baseline to compare other flooring products to. Alternatives were found with the help of circularity consultant 172 Impact and members of the TSH design and development teams.

Alternatives were considered based on their cost, CO2 emitted during the life-cycle of the product, look, installation process, material production, production location, operational considerations, life-span, end of life strategy and circularity notes such as cradle to cradle certification. CO2 lifecycle calculations were made using the online tool, OneClick LCA to calculate total carbon use of product. Based on the overview seen in appendix 9, two products were selected to compare to the baseline product. These were Senso unicolor poured resin flooring and Tarkett IQ One homogeneous vinyl. These products were selected based on their Cradle2Cradle (C2C) certifications, aesthetic and durability.

The C2C certificate assigns an achievement level in five categories, and the overall score is determined by the lowest score awarded in any of the five categories. The scores given can be basic, bronze, silver, gold or platinum. The baseline product, Bolidt 525 has no C2C certificate and a price of €54,680 to fill the first-floor space of 1,367m². The selected alternatives are Senso unicolor, which is a poured resin flooring with a silver C2C certificate and Tarkett IQ One, a vinyl flooring with a gold C2C certificate. An overview of the comparison between the products can be seen in table 6.3.

Table 6.3: Comparison between traditional flooring and circular flooring

	Material production	Production location	Operational considerations	Life-span	End of life	C2C certification level	Notes	Cost	Total Cost (cost/sqm x 1,367)	Cost over baseline
Bolidt 525 (traditional flooring)	85% responsibly harvested materials	produced in NL, most raw materials from Europe, some from abroad	Use normal chemicals and cleaning products	10-15 yrs, then apply new coat	No plan – can be base for future flooring	-	baseline product	€40/sqm installed price in the NL	54,680	0
Senso unicolor (circular flooring)	65% plant oil 25% natural quartz 5% additives 5% isocyanates	Quartz from Germany, produced in NL	Vacuum, water, mop – chemicals discouraged	Indefinite, can be resealed	Can be "recycled" – never done	silver		€70/sqm installed price in the NL	95,690	+41,010
Tarkett IQ One (circular flooring)	59 % natural raw materials – local suppliers when possible 25% post installation waste reused	Sweden	Basic chemical cleaning	15-20 yrs	Pay Tarkett to take it back – never done	gold		€50/sqm product price, excluding installation and polish price	68,350	+13,670

Traditional flooring vs circular flooring

Comparing the traditional flooring product, Bolidt 525, to the C2C certified products by Senso and Tarkett there are some differences to be considered. Using the categories measured by the C2C certificate and listed in table 6.3 it can be seen that the Tarkett product has a better overall rating than the Senso product. Both the Tarkett and Senso products have a C2C certificate while the Bolidt product does not. This does not necessarily mean that the Bolidt product is less circular than the other two, but it is harder to compare it because less information is provided, or it is provided in a way that makes it more difficult to compare directly. Another aspect to compare is the price. The Bolidt product is less expensive than Tarkett and Tarkett is less expensive than Senso. The last aspect to compare is preference. TSH is looking for products that are durable and can withstand the everyday wear and tear made by students. They are also looking for a specific aesthetic that may or may not be available in all products.

These options will be discussed in the expert panels with the objective of understanding strategic and operational considerations of each option.

6.2.4 Circular energy

The next material flow to investigate is energy. This research has concluded that a circular building should be energy neutral. This was also seen in case studies, the Hotel Jakarta is an energy neutral building with an EPC of 0, reached by reducing energy required and generating all necessary building energy on site or through PV at a distance. TSH Delft is predicted to have an EPC of 1, as required by the building code. For TSH Delft to be a circular building, an investigation will be done into improving from the currently calculated EPC of 1 to an EPC of 0.

Nieman, the building physics consultant on the TSH Delft project performed the EPC calculation. The EPC calculation includes energy needed for use in heating, cooling, ventilation and lighting. Electricity generated is from geothermal system and PV cells. An overview of all energy used and generated is found in figure 6.6.

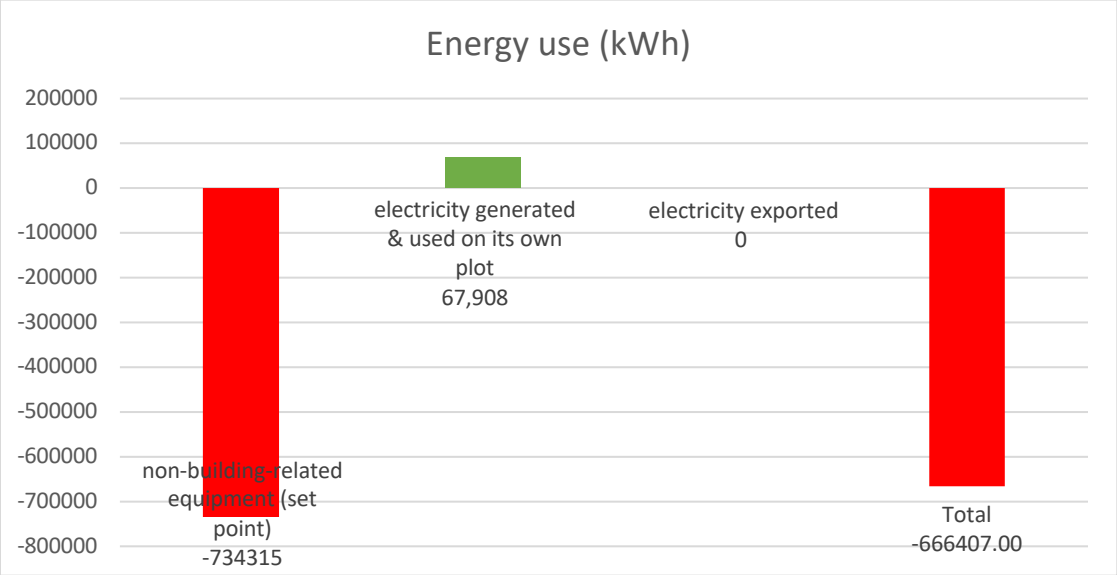

Figure 6.6: Annual amount of energy used and generated based on EPC calculation by Nieman

Table 6.4: Comparison between traditional energy use and circular energy use

	Traditional energy use	Minimum building installation energy use	Circular energy use
EPC	1	.81	0
Energy use/year (kWh)	666,407	602,728	0
CO2 emissions (kg/year)	187.293	151.388	0
Cost of energy/kWh (€)	*.07	*.07	*.07
Total energy cost/year (€)	46,648	42,190	0

*(J. Muis, personal communication, 10 May, 2019)

Traditional energy use vs circular energy use

Figure 6.5 shows the predicted energy calculation for TSH Delft. The goal of this test case was to understand what it would take to make the current design for TSH Delft energy neutral. By maximizing all of the building inputs that make up an EPC calculation such as insulation, heating, water heating, ventilation, solar energy generation, TSH Delft can reach an EPC of .809. It is important to note that this is looking at the EPC calculation after the final design was approved, meaning more changes could have been implemented at earlier stages. Both EPC calculations can seen in appendix 10. This would reduce building energy use, CO2 emissions, and building related cost of energy per year, as seen in tale 6.4. For TSH Delft to be energy neutral, changes in building design and layout would be necessary, and reaching an EPC of 0 would be very difficult (M, Koot, personal communication, 22 May, 2019).

These options will be discussed in the expert panels with the objective of understanding the advantages and challenges of making TSH Delft energy neutral.

6.2.5 Circular water

The last resource flow to consider is water. The Dutch Green Building Council describes the performance characteristics of water in a circular building as "water is managed in a 100% circular fashion" (Kubbinga et al., 2018). This research has concluded that circular water use means water leaves the building at the same purity it came in. This initiative was seen in case studies as well. The Hotel Jakarta collects rainwater to be reused for watering indoor plants. The QO Hotel also collects used shower water to be reused in floor heating system, helping The QO reach a 42% savings over baseline water calculations. GPR Gebouw awards additional points for circular water use, suggesting to (1) reuse greywater in toilettes (2) reuse rainwater in toilettes (3) reuse rainwater for outdoor gardens (GPR, n.d.) Options 2 and 3 will be tested at TSH Delft for a comparison between traditional water use and circular water use.

To manage water in a circular way an investigation into rainwater collection and reuse for TSH Delft will be completed. In combination with water consultant GEP and MEP engineering consultant Bectro, a rainwater collection and reuse calculation was made. The first system is designed to collect and filter rainwater to be reused in toilettes throughout the hotel. The second system is designed to collect and store rainwater to water plants on site. Both options reuse water collected from the site. Table 6.4 shows an overview of costs and predicted water used and saved compared to the traditional water use.

Table 6.5: Rainwater collection calculations

	Baseline: current water use	System 1: collect and reuse rainwater in all toilettes	System 2: collect and reuse rainwater in ground floor toilettes	System 3: collect and reuse rainwater for plant watering
Cost of rainwater collection system*	-	€170,000	€80,000	€15,000
Estimated toilette water use/year**	4,000,000L	•	•	•
Estimated planting water use/year **	96,000L	•	•	•
Cost of water ***	.85/1000L	.85/1000L	.85/1000L	.85/1000L
Total cost of water	3,481	268	3,294	3,400
Savings (€ /year)		3,213	187	81

* cost estimates provided by (M. Koot, personal communication, 22 May, 2019)
**based on 6L toilettes
*** (Tarieven ,n.d.)

In the current water use calculations TSH Delft is predicted to use 4,000,000L of water/year on toilets, and 96,000L/year on planting. This case tested reusing rainwater in all toilettes, ground floor toilettes and for plant watering. The costs and savings calculations can be seen in table 6.5.

These options for collecting and reusing rainwater to manage water in a circular way will be discussed during the expert panels.

6.3 Conclusion

The intention of this chapter was to introduce the graduation company with which this research is being carried out, TSH, along with their future ambitions for real estate and circularity. TSH was used as a test case to validate research results and obtain a better understanding of a traditional implementation compared to a circular implementation. Three test cases were made using TSH Delft as an example case for implementing a circular initiative in materials, energy and water. Conclusions can be made about the differences between a traditional implementations and their circular alternatives.

For materials, circular flooring was tested in comparison to traditional flooring. The differences in circularity of a material such as flooring can be measured using the C2C certificate. A product with a higher C2C certificate has better performance the categories of material health, material reutilization, renewable energy and carbon management, water stewardship and social fairness. An additional aspect that was compared were price. Both of the circular flooring options cost more than the traditional option.

For energy, TSH Delft was used as a test case to compare the traditional building energy use to an energy neutral building. In the traditional energy case, the building met the regulatory requirements with an EPC of 1, using 666,407kWh of electricity/year, costing €46,648/year. Through this test case it was proven to be impossible to make an existing design energy neutral, only reducing the EPC to .8 and requiring a significant additional investment. It can be concluded that an energy neutral building needs to be a goal from the beginning of a project to be included in original design and made a reality.

For water, TSH Delft was used as a test case to compare traditional water use to circular water use. From the three test scenarios carried out, it can be concluded that rainwater reuse can have a big reduction on resource use, but with the low cost of water in the Netherlands it is expensive to implement and has long payback periods.

7 Expert panel

In this chapter the outcomes of the expert panel are explained. First, a reasoning for using an expert panel as a research technique, then a discussion about how the expert panels were designed and members were selected, followed by an overview of content and analysis of each panel. The goal of the expert panel is to discuss the measure the validity of findings and discuss operational and strategic means for implementing circularity in hotel buildings and operations.

This chapter will answer sub-question 6-7:

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6 What are the strategic advantages and challenges for implementing circularity?
7 What are the operational advantages and challenges for implementing circularity?

Research technique
The research technique used for the expert panel is the focus group. A focus group is used to (1) emphasize a specific theme or topic that is explored in depth and (2) allows individuals to discuss a certain issue as members of a group (Bryman, 2012). In a focus group the interest is on "how people respond to each other' views and build up a view out of the interaction that takes place within a group". Open-ended statements were used to allow participants to raise their own concerns within the discussion (Bryman, 2012, pg. 501). The focus groups are meant to be guided by the researcher in an unstructured setting.

Design of panel
The expert panels are carried out in two sessions. Session one is focused on the implementation of circularity as a strategy. Session two is focused on implementation of circularity operationally. Both sessions are designed to validate findings and discuss implementation within the case of TSH. Bryman (2012) suggests the size of groups to be about 6-10 people and to account for no-shows on the day of panel sessions. All panels will be video recorded to make for a clear understanding of what was said during the panel, and for the researcher to be able to focus on the panel at hand rather than taking notes.

7.1 Session 1: circularity as a strategy

Selection of members
This session was held with the management team of TSH. This group makes decisions about the strategic direction of the company and their input highlights the strategic considerations of the test cases.

Table 7.1: Expert panel members: strategy

Member	Role
Katherine Beisler	Moderator
Rienk Oosterhof	Chief Real Estate Officer, Investment and Development
Melike Çatalgöl	Technical Development Manager
Amber Westerborg	Impact Manager
Nicolas Castanet	Chief Financial Services

Lucas Rijckmans	Chief Corporate Services
Joost Serrarens	Chief Operational Officer
Jason Steere	Chief Brand Officer
Denis Montrelay	Executive Director
Apurva Pratap	Chief Commercial Officer

7.1.1 Content of the session

The content of the session is based on the objective of understanding the strategic considerations for implementing circularity in hotel buildings and operations. They also verified the research findings by giving an additional opinion on findings that were not consistent between theory and practice.

7.1.2 Program

Date: Friday, May 24th
Time: 9:30-10:00
Location: TSH Amsterdam

Table 7.2: Expert panel program: management strategy

Part	Time	Description
1: Introduction	9:30-9:35	Entry
	9:35-9:45	Welcome -overview of research -goal of meeting -panel members state their intentions and motivations for circularity at TSH Open-ended questions for panel: • TSH is motivated to implement circularity in real estate and operations because… • The circularity goals of TSH are…
2: Circularity at TSH What are the strategic considerations for implementing circularity in hotel buildings and operations?	9:45-9:55	Presentation of 3 test cases Statements for discussion on each business case • The strategic considerations for these circular alternatives are…
3: Conclusion	9:55-10:00	Wrap-up

7.1.3 Review of expert panel

The strategic expert panel lead to a robust discussion of the future of TSH and how circularity should or should not be implemented. The outcomes of the expert panel are as follows:

TSH is motivated to implement circularity in real estate and operations because…
-obligation to planet and people otherwise just creating landfill
-guests expect it
-futureproof to changing regulations and guest demands
-opportunity to make an impact, by influencing guest behaviors after they leave the hotel
-desire to be at the forefront of hospitality

The circularity goals of TSH are…
-10% as included in TSH CSR strategy
-to be ahead of what is coming next, whatever it is

-to add value to real estate
-to future proof real estate
-to communicate a sustainable story to our guests that they understand

Strategic considerations of test cases:

- Change in design thinking- if TSH decides to implement all circular initiatives it will require a (positive) change in design thinking
- Preserve value of real estate-when thinking to implement circularity initiatives, TSH must also think about how to make real estate last longer
- Position as a frontrunner
- Add to brand story
- Attract future investors- investors increasingly want to buy sustainable buildings
- Attract future guests- guests increasingly care about the full story behind the hotel
- Influence guests- they can take behaviors or ideas they learn at the hotel home with them
- Impact on the city- with a goal to change local neighborhoods, these initiates can influence an area in a positive way
- Add value to real estate- not currently confirmed but believed

Strategic challenges of test cases:

- Inflexible over time- choosing durable circular materials proposes a challenge to the current TSH model of updating interior design every 5 years. This led the panel to discuss the differences in material selection, reusability vs durability.
- Guest acceptance - will they react positively to these initiatives
- Communication- initiatives need to be communicated effectively for guests to understand them
- Maintenance challenges
- Investment strategy- longer investment timelines needed to make implementation attractive

7.1.4 Verification of findings

The below advantages and challenges did not have an agreement between theoretical and empirical research. For this reason, they were validated using the expert panel. The responses of the expert panel are shown below.

Advantages of circular hotel buildings and operations include:

	Yes	No
Reduced environmental impact	X	
Reduced shadow costs		X
Additional revenues	Not sure	Not sure
Limiting risk	X	
Winning awards	X	

Challenges of circular hotel buildings and operations include:

	Yes	No
Finding suitable partners	X	
Guest behavior	X	
High IT costs		X
Additional financial investment	X	

7.1.5 Conclusion of expert panel: management strategy

The management team was overall very positive about the test cases and implementing circularity at TSH. They see it as the obligation of TSH to be sustainable, and that if TSH presents itself as a frontrunner, this should include the way their hotels are built. The management team was not intimidated by setting bold goals but wants to follow through with them if they do and communicate them effectively to guests. The management team also feels that measurement is key to reaching goals. Measurements can also be communicated through brand to inform guests of the steps that TSH is making. Right now being a frontrunner means that TSH wants to lead on sustainability and circularity, but they also want to be a frontrunner on future trends.

7.2 Expert panel 2: circularity and operations

Selection of members

Members are selected because their role within operations at TSH, their knowledge of circularity and / or hotel operations. All members have a direct tie to the operations decisions within TSH.

Table 7.3: Expert panel members: operations

Member	Role
Katherine Beisler	Moderator
Melike Çatalgöl	Technical Development Manager
Itziar Benedicto	Design Project Manager
Kristel van Pinxten	Procurement Director
Jan-Pieter Muis	Director Asset Management

7.2.1 Content of the panel

The content of the session is based on the objective to understand the operational considerations for implementing the circular test cases. The structure and outcomes of the panel are seen below.

7.2.2 Program

Date: Friday, May 24th
Time: 1:30-2:30
Location: TSH Amsterdam City: Collab Network

Table 7.4: Expert panel program: operations

Part	Time	Description
1: Introduction	1:30-1:35	Entry
	1:35-1:45	Welcome -overview of research -goal of meeting -panel members state their intentions and motivations for circularity at TSH
2: Circularity at TSH What are the operational considerations for implementing circular initiatives in hotel buildings and operations?	1:45-1:58	Presentation and discussion of test case 1: Circular flooring -operational considerations for each panel member
	1:58-2:10	Presentation and discussion of test case 2: Energy neutral building -operational considerations for each panel member
	2:10-2:25	Presentation and discussion of test case 3: Rainwater collection and reuse -operational considerations for each panel member
3: Conclusion	2:25-2:30	Wrap-up

7.2.3 Review of expert panel

Members of the panel are motivated to implement circularity because…
-personal interest to perform role in a better way
-personal interest to understand how products are made
-use TSH Delft as a test case for future projects
-procure three circular products
-idea to go circular was pitched internally and approved a few years ago

Operational advantages of test cases
The operations panel did not see any advantages to the test cases themselves. They did see some advantages into the process of investigating circularity initiatives, they had a better understanding of how products were made.

Operational challenges of test cases
The operations panel saw many challenges in the test cases. They were:

- Availability: procurement needs to be able to guarantee that products will be on site when needed, this does not always give them time to investigate circular alternatives before purchasing
- Contracts: if products are able to be sold back or leased this will have an effect on how a bank values a building, and if this is legal for TSH. They believed this could be worked around.
- Durability: TSH is very concerned with durability, if a product is not at least as durable as the existing product, it will not be approved.
- Maintenance: These test case of the energy neutral building and rainwater reuse propose many additional maintenance requirements
- Reliability: The operations panel challenged the claims made by manufacturers to make sustainable products, is it just marketing?
- Aesthetics: All circular alternatives need to be approved by the design team for their aesthetic value

7.2.4 Conclusion of expert panel: operations

The operations panel found it beneficial to investigate circular initiatives for their own knowledge, but they did not see any advantages to the initiatives themselves "I know the truth behind products….recycled options are not always the most circular" (I. Benedicto, personal communication, 24 May, 2019).

They did see many challenges such as: availability, contracts, durability, maintenance, reliability and aesthetics. "there are some challenges (with contracts) about ownership, and what can you insure and what if we go bankrupt how would the bank regard it?" "there is a tradeoff between making sure products are available on time...and you can't always take the time to assess all options in a circular form" (K. van Pinxten, personal communication, 24 May, 2019).

After investigating circular implementations, it can be concluded that the decision to develop a circular hotel needs to be made at the beginning of the project, "the design needs to be from the very beginning thought as circular, and not once its done rethink everything. Its way more difficult once you have a concept signed off, to think in a way that does not effect the look, it's a challenge" (I. Benedicto, personal communication, 24 May, 2019).

Through the test case of TSH Delft the expert panel members feel that they are struggling to make a traditional design circular and that it would have been much easier if this decision was made from the start. Lastly, the operations panel is interested in implementing technology to monitor and measure the building.

7.3 Conclusion

The expert panel method was used to discuss the three circular initiatives tested using the case of TSH Delft. This allowed the panels to speak about specific initiatives in a practical and concrete sense rather than about the general topic of circularity as a whole. This meant that he expert panels could comment on things like aesthetics, costs, and guest interaction with the initiatives rather than theoretical implementations.

From this step in research it can be concluded that the strategic considerations of circularity initiatives in hotel buildings and operations are:

- Changes needed in design thinking
- position in the market
- brand story
- future investors
- future guests
- impact on neighborhood and city
- guest behavior
- value to real estate
- ability to adapt to changing trends
- guest experience
- communication strategy
- investment strategy

Additionally, the operational considerations are:

- Availability
- Durability
- Maintenance
- Contracts
- Reliability
- Aesthetics

8 Conclusions and discussion

The aim of this chapter is to draw clear conclusions on the main research question that was answered throughout this research, the conclusions are made in the first part of this chapter. After conclusions are made, a discussion is presented in part 2 of this chapter. In part 3 of this chapter a discussion on validity and reliability of this research is presented.

8.1 Answering the main research question

Through this research the sub-research questions were answered in their respective chapters. From this the main research question can be answered. Using theory, case studies and expert panels the outcomes (advantages and challenges) of implementing circularity initiatives were documented. Additionally, the expert panel provided practical strategic considerations for implementation using the test cases as an example. These have then been grouped into strategic and operational considerations as seen in figures 8.1 and 8.2. This forms the answer to the main research question:

What are the strategic and operational considerations for implementing circularity in hotel buildings and operations?

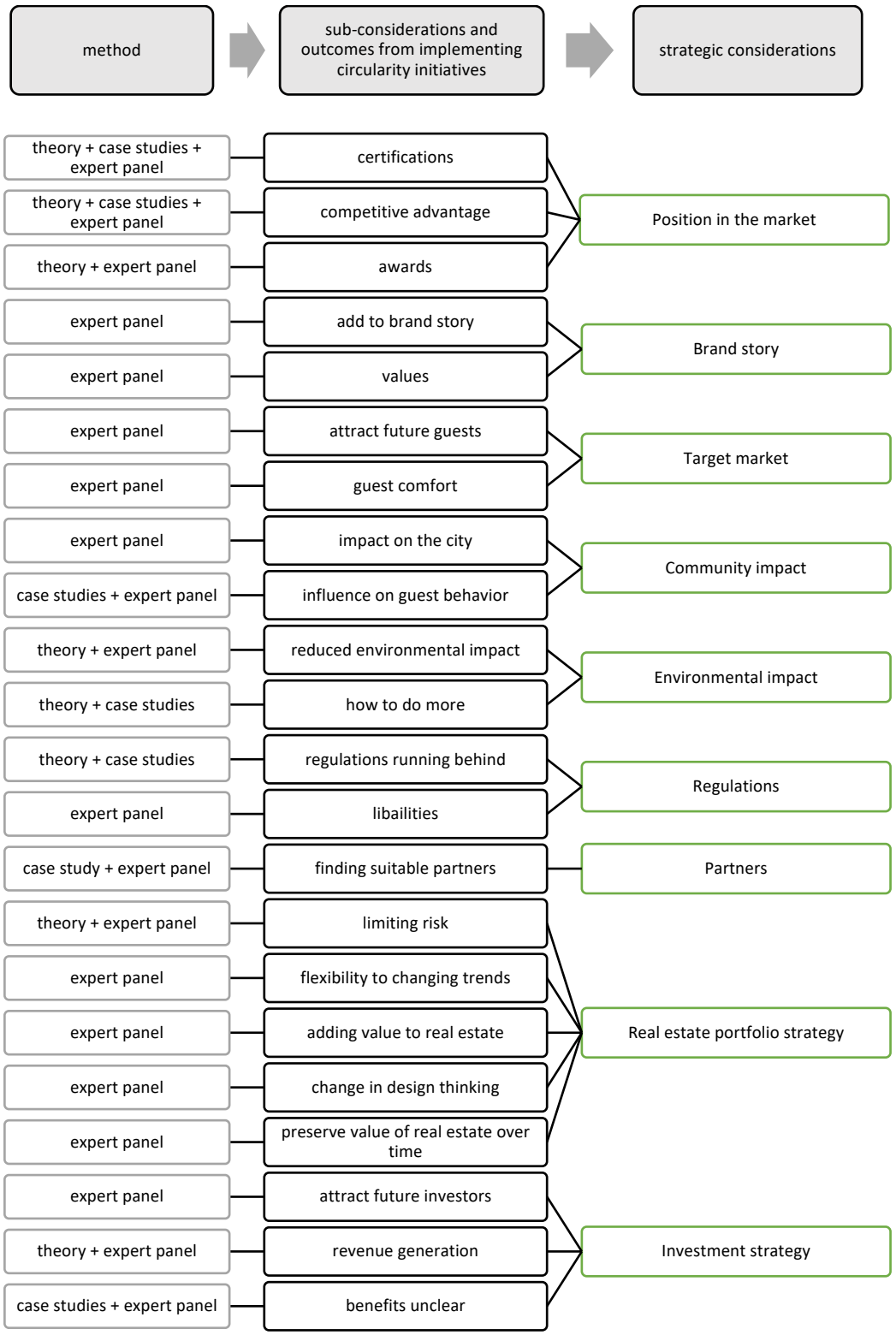


Figure 8.1: Strategic considerations

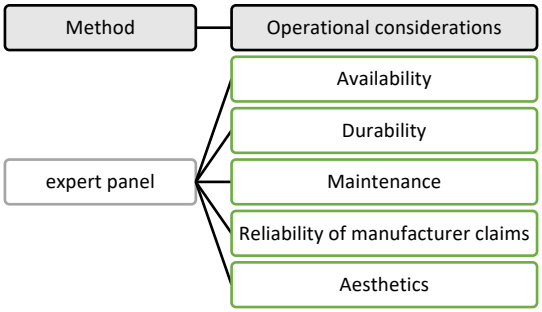


Figure 8.2: Operational considerations

Figure 8.1 and 8.2 show the method, sub-considerations and finally overarching strategic and operational considerations for implementing circularity in hotel buildings and operations. Many sub-considerations were found through the methods shown in the figures. To get to the core of what these considerations represented and make them easier to understand they were grouped together and renamed into strategic or operational considerations. These also represent the topics that were relevant to the consideration. For example, certifications were found as a consideration in theory, case studies and in the expert panel. When actors spoke about them it was in reference to the position in the market.

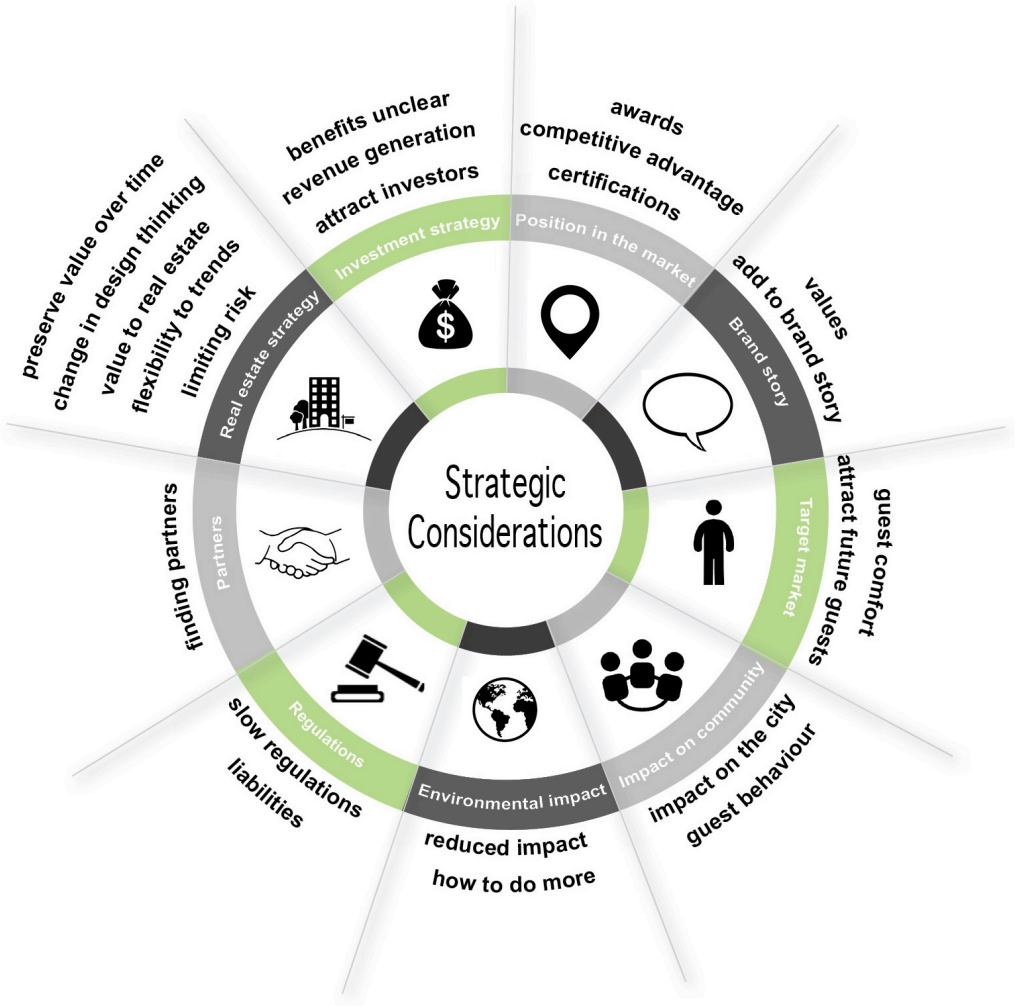


Figure 8.3: Strategic considerations infographic for hotels

Based on the outcomes of this research it can be concluded that implementing circularity in hotel buildings and operations has a far greater impact than on the building itself. The hotels studied in this research are public urban anchors and have the potential to make an impact on the community and their guests. This makes the considerations for implementing circularity much broader than the costs or savings for implementation but on many strategic and operational factors.

Figure 8.4: Operational considerations infographic for hotels

Considerations can include facts or motives taken into account when deciding to implement a circularity initiative instead of a traditional initiative. This research can conclude on many considerations including and beyond the scope of real estate. Figures 8.3 and 8.4 are to be used by hoteliers when deciding to implement circularity. These considerations should be taken into account by hoteliers when deciding to implement circularity in hotel buildings and operations.

8.2 Discussion

The outcomes of this research are discussed in this section. The discussion will include (1) outcomes and existing theories (2) outcomes and practice (3) limitations, validity and reliability of this research.

8.2.1 Discussion on theory

The literature review of this research covered the topics of resource use, circularity, circularity in the built environment, and circularity in the hotel industry. This section will discuss the outcomes of this research and the theories found in literature as well as the main sources used.

Resource use
The literature on resource use linked an increase un resource use following the industrial revolution to an increase in global greenhouse gas emissions and global warming. This information is based on scientific facts and is more concrete than the other topics covered in this research.

Circularity
The literature on circularity that provided the most insight came from Kirchherr et al. (2017) and the Ellen MacArthur Foundation (2013). Kirchherr et al. highlight the confusion around the concept of a circular economy that is also seen through the many definitions found in literature and the general confusion about the topic in practice. In contrary the Ellen MacArthur Foundation communicates a clear definition of a circular economy. The definition provided by The EMF is broad enough to be applied to all industries. As Kirchherr et al. show, most definitions of the circular economy are focused on economic prosperity. Separating the economic aspect out, circularity focuses on environmental quality and social equity. A concrete definition on circularity is more difficult to find in literature.

Circularity in the built environment
Much literature exists on how to incorporate circularity in the built environment. Because circularity is a relatively new idea in the sustainability movement there is not yet one clear method to incorporate circularity in the built environment. This research relied most on sources from Brand (1994), the Dutch Green Building Council (Kubbinga et al, 2018), ABN AMRO (van Odijk and van Bovene, 2015) and Rau and Oberhuber (2016) to form an idea of what circularity means for the built environment. These sources provided evidence for which this research is structured. Practice helped to further validate or contradict the theories found in literature.

Circularity in the hotel industry
With circularity in general as an emerging topic, there is even less research on circularity in hotel buildings and operations. This research relied on literature on sustainability in the hotel industry, including the growing demand for sustainable accommodation from Kang et al. (2012) Booking (2018) and Walsman et al. (2014). Banks such as ABN AMRO have released reports encouraging hotels to lower their environmental impact through implementing circularity initiatives in energy and water and in turn future proofing their real estate.

The Circular Hotels Leaders' Group in Amsterdam have been working together to establish a 7-step plan to a circular hotel and a list of circularity opportunities. This leaders group makes up the front runners in Amsterdam for hotel circularity, but they still have many unknowns. The added value of this research is to advance circularity research for hotel buildings and operations and provide insights and concrete examples for implementing circularity in hotel buildings and operations.

8.2.2 Discussion on practice
Using the case study method this research was able to gain insight into the current state of circularity in hotel buildings and operations. Amsterdam's Circular Hotels Leaders' Group is made up of 12 member hotels, providing valuable case studies for this research. From the 12, three were selected for case study research. All case studies provided information about the circular initiatives they had implemented as

well as their motivations for implementing circularity and the advantages and challenges they experienced. The added value of the case studies is discussed in this section.

Case Study 1: The QO Hotel
The QO Hotel is undoubtedly a frontrunner in circularity. This is because it was conceived from the beginning as a sustainable hotel. The most significant insights from this case study were that to reach the high standards for sustainability desired by the development team, extra time and flexibility was needed to allow for innovation. The project did not have prescribed circularity goals but rather made decisions that seemed like the right thing to do. This eventually earned the QO Hotel a LEED Platinum certification and some awards for design sustainability, drawing additional attention.

Case Study 2: Hotel Jakarta
The Hotel Jakarta is another clear frontrunner in hotel circularity. Motivated by the City of Amsterdam to meet the goals of the tender for the site, Hotel Jakarta is an energy neutral building that also incorporated many circularity initiatives into their operations. A significant insight from this case study was the power of the government to motivate sustainable development. If the City did not make it a requirement in their tender WestCord, the developer of Hotel Jakarta would not have proposed such a sustainable solution. Additionally, Hotel Jakarta demonstrated that regulations are running behind, they had difficulty certifying their atrium for fire safety because of its sustainable wood design. This project also had difficulties achieving their desired BREEAM outstanding score because of the mixed-use function.

Case Study 3: Conscious Hotel Westerpark
The Conscious Hotel Westerpark differs from the other two case studies in that this hotel does not have specific goals for sustainable building or operations but instead to do everything consciously. This often includes circularity initiatives but also many social initiatives. Conscious Hotel Westerpark believes that about 20% of guests choose the hotel specifically because of their mission statement, providing a distinct competitive advantage over other hotels.

Circularity in practice
The three case studies were the clear frontrunners on circularity in hotel buildings and operations in Amsterdam at the time of this research. All three case studies were opened in 2018, very recently, and the trend towards circularity is only expected to grow. This is also supported by the City of Amsterdam's mandate for sustainable and community supportive hotel development.

In all case studies initiatives were presented as sustainable or even circular that would not meet this research's definition of circularity, and even their ability to be labeled sustainable needs to be looked at critically. For example, The QO Hotel shared that the entire room can be controlled by an i-pad. This does save the material needed for printing out a few sheets of paper to explain the room, but are the added materials needed to make the i-pad less impactful? While the term circularity seemingly comes up everywhere, it is necessary to be critical about what it really means.

While all three case studies provided examples of circularity in the use of materials, energy and water none meet the definition of circular real estate provided in section 8.1.2. This could be because circularity is new trend in sustainability, and there is not a concrete consensus about how to implement it. It could also be that fully circular hotel is not the goal, or not yet attractive for hoteliers, either for financial or other reasons. This leaves an opportunity for hotel buildings and operation to continue to innovate to reach the goal of a truly circular hotel.

At the start of this research the expected strategic and operational considerations were expected to relate mostly to real estate with some interest in competitive advantage. Surprisingly, the considerations found within TSH extended well beyond these expectations. The decision to incorporate circularity initiatives was very much a management decision concerned with how the company wants to be perceived and the strategic direction it should take towards the future. At TSH, once the decision is made by the management team, the real estate team would follow by incorporating the circularity initiatives. For TSH, the real estate is the brand. This means the direction of the brand is intertwined with the direction of the real estate as a means for communicating priorities to the public. This might not be true for all hotels. Other hotel brands may be less concerned with branding and therefore circularity initiatives would be less connected to brand strategy and focus only on real estate strategy. This research provides a list of considerations. If a consideration does not apply to a hotel, that hotel can skip over that consideration and move onto the next or use the consideration as a suggestion to understand how it would affect their brand. Further research would need to be done to understand if all considerations apply to other hotels besides TSH.

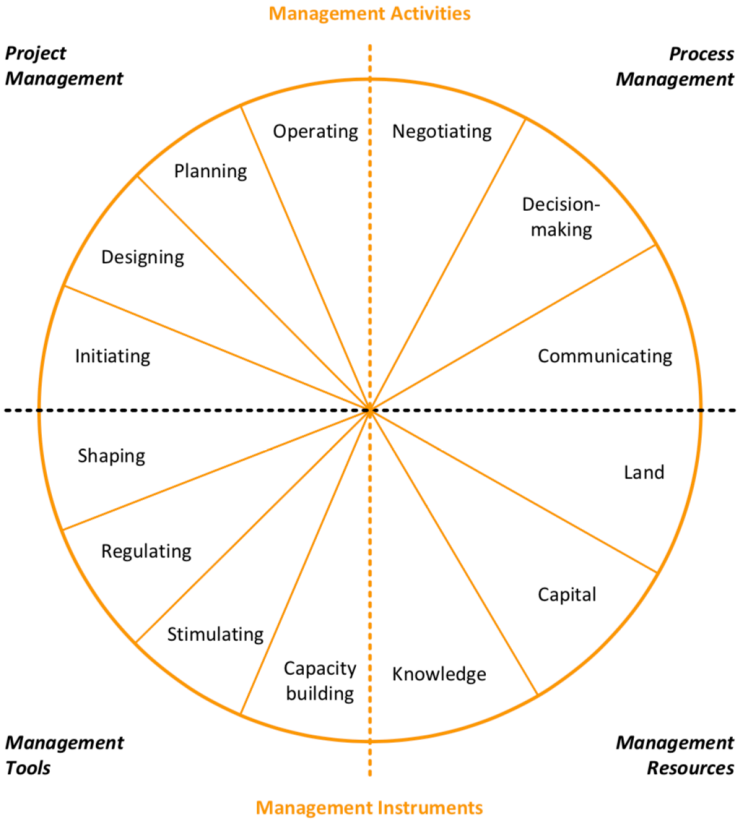
Urban area development to support circular hotel development

Circular hotel development is one component to sustainable urban area development, particularly mixed-use development. Mixed-use developments contain a mixture of uses in buildings and land, meaning that different single use buildings are on one site or that one building is occupied by different types of tenants (Regales, 2017). The goal is to combine living, working and leisure together in one area which reduces environmental impact (environmental sustainability), allows businesses to establish and grow, increase job opportunities (economic sustainability) and offers high-quality environment for the community (social sustainability) (Reid, 2013).

In these complex mixed-use urban developments, there are many actors, each working toward their own independent goals. In the Netherlands, the leading actor is shifting from the local governments to the private sector (Huismans & Vaan, 2011). This means that local governments are shifting to a facilitating role while development is left to private markets, leaving private-sector led urban area development to emerge as a potential strategy for developing sustainable areas (Regales, 2017 and Heurkens & Hobma, 2014). In figure 8.1 the main stakeholders in urban governance are seen. Local and national governments, while now playing more of a facilitating role, can still provide incentives to motivate private actors to develop sustainable areas.

Figure 8.1 Main stakeholders in urban governance (Layke et al., 2016)

In the case of a public-private sustainable urban area development, there are many tools that different actors use to reach their goals, seen in figure 8.2. Regales (2017) suggests that public parties can make use of the stimulating and capacity building management tools to encourage sustainable urban area development. Stimulating tools include encouraging new development in otherwise undesirable locations, price-adjusting such as providing development grants, risk reduction. Capacity building instruments include raising capital, culture shaping, network building and development of human capital (Adams & Tiesdell, 2013).

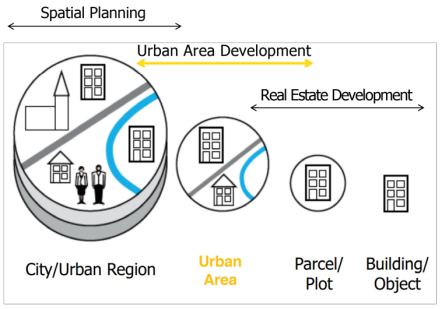


8.2: Conceptual public-private urban management model (Heurkens, 2012)

When local governments want to develop sustainable urban areas, they can use the tools described to incentivize private parties. The private hotel developers studied in this research were motivated by some of these instruments already. To encourage further circular hotel development local governments should stimulate towards the goal of circular urban area developments. This could include capacity building through systems thinking, such as how plots in an urban area can collectively generate energy or reuse and purify water. Examples of this have already been brainstormed within the Circular Hotel Leader's Group in Amsterdam, such as a joint logistics hub for storage and deliveries to reduce transportation.

8.2.3 Discussion on current research

Within the Sustainable Area Transformation lab at TU Delft graduate student H. Luijt (2019) is currently researching circularity in urban area development. Her research covers the urban area, between the scales of parcel/plot and city/region as seen in figure 8.3. Her research relies on existing information on spatial planning and real estate development as well as case studies to form the basis for circularity in urban area development.



8.3: Urban Area Development (Heurkens, 2018)

This research is focused on circularity at the scale of real estate development, but the opportunities for circularity at building or plot level should not ignore the urban area or even the city. As shown by the solutions of the Circular Hotel Leaders' Group in appendix 3 there are opportunities for hotels across a city to work together on circularity solutions, such as using one main logistics hub or collecting and repurposing waste on an urban area scale. This research also found the need to cooperate at an urban area level when implementing circularity initiatives such as a geothermal heat pump or rainwater collection tanks that may need more space than the plot will allow. In these situations, urban areas can benefit from cooperating. Luijt's (2019) research investigates the main factors that contribute to circular urban area development. The factors she found included: circular building material flow, spatially adaptive urban areas, efficient energy systems, closed water systems, reuse, collection and logistics of waste and stimulating the local economy. This research found that circular hotels can contribute all of these factors of a circular urban area. Specifically, hotels have the ability contribute to spatially adaptive urban areas by providing flexible public spaces. Furthermore, circular hotels can contribute greatly to stimulating the local economy by contributing to a mixed-use development and providing space for repair cafes and opportunities to make use of the sharing economy. Luit's research shows that circular hotels can be a key contributor to circular urban area development.

The other benefit hotels provide to sustainable area transformations and circular urban area development is the opportunity to communicate and influence a large number of people. Hotels can engage community members by providing public spaces or holding public events. Hotels can also inform guess of their work on sustainability, and creatively influence guest behavior to use less resources. A hotel can be a strong anchor to a circular urban area development as well as a communication tool within the community.

8.3 Reliability, replication, limitations and validity.

8.3.1 Reliability and replication

Reliability refers to, "whether the results of a study are repeatable" and replicability means "a study must be capable of replication" (Bryman, 2012, pg. 46). This research aimed to maintain both reliability and replicability through a clear explanation of methods, laid out in chapter 2. Additionally, all results and sources are laid out in chapter 4. With the exception of personal communication, all interviewees could always change their opinion in the future, all results can be replicated by future researchers or built upon in further studies.

8.3.2 Limitations

There are many limitations to this empirical research. First, this empirical research used three case studies and one test case to derive results. While the three case studies are the frontrunners on this topic in Amsterdam, the results may not reflect the situation of all hotels. A limitation of case studies is that they provide in depth information on three cases but may not reflect the broader situation of all hotels. The case studies used aimed for variety in development strategy, but many contextual factors were the same. This was beneficial for the research as it made them easier to compare and to make recommendations in this context but limits the applicability of findings. Additional international case studies may lead to different findings. The findings and recommendations of this research are limited to hotels with similar criteria as the case hotels.

Second, all case studies used in this research have been in operation for less than 12 months. This makes it difficult for interviewees to know the long-term advantages and challenges associated with circularity in their hotel. In addition to their short operating times, the case studies had little qualitative or quantitative data about their hotel. Some advantages and challenges recorded were based on the interviewee's perception and not data.

8.3.3 Measurement validity

Measurement validity refers to, "the question of whether a measure that is devised of a concept really does reflect the concept that it is supposed to be denoting" (Bryman, 2012, pg. 47). The aim of this research is to provide insight to hoteliers on the strategic and operational considerations of implementing circularity in hotel buildings and operations.

To operationalize what implementing circularity in hotel buildings and operations meant, first circularity had to be defined, along with circularity in real estate and finally circularity in hotel buildings and operations. Using this constructed definition, the strategic and operational considerations could also be researched. This research originally aimed to measure the value of circularity, but when it was discovered that this could not yet be done, the aims of the research shifted towards a question that could be answered with existing knowledge. Measuring the value of circularity would require further development on the topic and additional research. It is believed that by using case studies and a test case the strategic and operational consideration for implementing circularity in hotel buildings and operations could be answered.

8.3.4 Internal validity

Internal validity relates to "…whether a conclusion that incorporates a causal relationship between two or more variables holds water" (Bryman, 2012, pg. 47). The conclusion of this research incorporates many variables that were used to understand the strategic and operational considerations of circularity. Their relationship and inclusion in the conclusion were tested through case studies and validated through a test case and an expert panel. This provides three layers of testing the verify the internal validity of the results.

8.3.5 External validity

External validity concerns "…whether the results of a study can be generalized beyond the specific research context" (Bryman, 2012, pg. 47). The external validity of this research was maintained through conducting exploratory interviews with representatives from beyond the case studies and graduation company. The research results were validated with the graduation company, making them most applicable for recommendations to the graduation company. This does not mean that results are only valid for the graduation company but also to other hotels looking to implement circularity.

The case studies method is inherently not externally valid, especially in this context where the case studies were selected for their uniqueness. The intention of the case studies was not to be able to generalize to other cases, but to gather information from front runners in the industry. What is applicable to other projects is the results of the research and recommendations made to practice. Because the case studies and test case all have many equal contextual factors such as location, the results are most applicable to projects with the same contextual factors. This does not mean that the results of this research do not apply further. The first part of this research focused on defining circularity in real estate and can therefore be used more generally. Further results of this research on circularity in hotel buildings and operations can form a framework for future projects outside of Amsterdam. The same is true within the graduation company. The results of this research are most applicable to hotels in the Netherlands, and as TSH expands around Europe each consideration will need to be looked at within the context of the new development. For example, rainwater collection and reuse is required and more financially feasible in southern European cities like Bologna.

The external validity of these results is also limited to hotels that are already considering implementing circularity. This research only conducted case studies with hotels that had the mindset to be frontrunners on this topic and does not include considerations for hotels that do not already have circularity on their agenda. This could be explored in further research or through an expert panel of non-frontrunning hotels to understand if the considerations found in this research are applicable to them or not.

Lastly, the expert panel was held with members of the graduation company, therefore the insight the panel provided is only valid to the graduation company. External validity could have been increased by involving representatives from different hotels to participate.

9 Recommendations

This chapter includes the recommendations that are the outcomes of this research. These recommendations are based on the conclusion of the main research question, sub-research questions and discussion. This chapter includes recommendations for the graduation company, practice in general, policy, and future research.

9.1 Recommendations for graduation company

Following the development cycle provided by TSH recommendations for considering and implementing circularity are provided. The original development framework can be seen in appendix 11. An overview of all recommendations along the development cycle can be seen in figure 9.1.

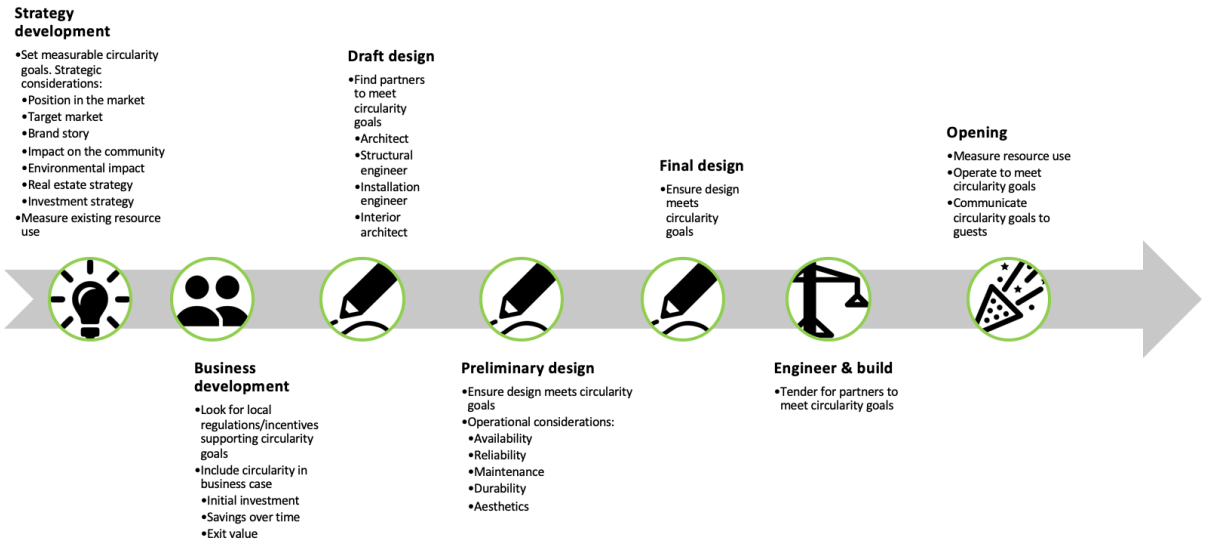


Figure 9.1: Recommendations for graduation company along development cycle

Recommendations for strategy development

Before the development process begins, decisions need to be made regarding strategy towards circularity. Recommendations include:

Set measurable goals considering:

position in the market, target market, brand story, desired impact on the community, desired environmental impact, real estate strategy and investment strategy. TSH has a written goal, "we aim to devote 10% of our resources, skills, love, energy and square meters to help change the world by making a positive impact however we can" and state that they are, "implementing our first initiatives and fine tuning our strategy towards being a circular company." The goals of making a positive impact and being a circular company are impossible to reach if they are not attached to concrete and measurable numbers. If TSH wants to be a circular company, a consensus on what that means needs to be reached, including concrete measurable goals.

Measure existing resource use

Some concrete goals have begun to be set in agreement with the bank ABN AMRO. TSH has an agreement with ABN that if they reach certain concrete and measurable goals, TSH will get a discount on

their investment margin. This has prompted TSH to take baseline measurements and set reduction goals. This is a good step, but all circularity goals should be quantified. This requires additional metering of energy and water use in order to better understand resource use, and where to reduce it. Detailed metering, through the use of smart meters will provide a more accurate picture of resource use throughout the real estate portfolio.

Recommendations for business development

The first phase of the development process is business development. For this phase recommendations include:

Perform regulation and incentive research

TSH is unique in that it develops throughout Europe. This means there is not a one size fits all solution to implementing TSH's circularity goals. Part of the business development should be an investigation to the local legislation or incentives that would support TSH meeting their goals.

Include circularity in the business case

Accurately measuring resource use also allows it to be accurately accounted for in a business case. Currently, investments in circularity look like additional investment costs in business cases, and the reduced resource use over the long term is not accounted for. Circularity should also be included in the residual value of the building after the investment cycle. Initial investments in materials that can be recycled, energy reduction and generation and water reuse should all add value to the building. This is currently hard to measure but as investors are looking to invest in sustainable buildings, this value should be accounted for. These values of circularity and additional investments needed should be included in the initial acquisition business case. "Asking investors for this additional investment makes it look like TSH is asking for additional money rather than making long term investments in future proof buildings." (L. Rijckmans, personal communication, 17 May, 2019).

Including circularity in the business case also means reserving resources, time, money and effort, to implement goals. Change is difficult and takes additional effort to succeed. Setting the structure for success is the first step to reaching it.

Another aspect to consider in the business case is the exit value. Buildings designed to be more flexible or adaptable to a future use have a better chance of being reused, even for another purpose. At the end of a hotel's life, it may have a higher exit value or attract a broader range of buyers if it can be easily adapted. Further research would be needed to understand the relationship between adaptability and exit value.

Recommendations for draft design

Find suitable partners

This includes architect, structural engineer, installation engineer and interior architect. In addition to including circularity in initial business case, it is also key to include circularity in the design and development from the start. Currently for TSH Delft the interior designer was asked to make a circular interior design, the EPC goal was 1 to meet government regulations and there were no water use requirements.

The interior designer was not given clear goals for a circular interior design. This led the interior designer to provide a design that did not meet the circularity expectations of TSH, and the internal design and development team to try to update the existing design. This challenge could have been avoided by

working with an interior designer that is skilled in circular use of materials and held to certain circularity standards.

Additionally, there were no goals for energy use beyond government regulations. TSH should set their ambitions for energy use and incorporate them in new projects from the beginning. For this research a business case was made for making the existing building design to reach an EPC of 0. This is not the way that energy goals should be incorporated. Lastly, there are currently no goals for water use at TSH Delft. Again, the goal for water use should be set at the beginning of a project, and then incorporated into the business case, design, and development.

Recommendations for preliminary and final design

Ensure design meets circularity goals

After finding suitable partners they must be held accountable to the agreements of the contract and meeting the circularity goals of TSH. Their commission should even be tied to meeting these goals and designs that do not should not be approved.

Consider operations requirements including:

Availability, reliability, maintenance, durability and aesthetics of design. All designs should meet the circularity goals and operational goals of TSH. This may require extra time and effort to implement over traditional products.

Implementing circularity strategies

Through the test cases at TSH a recommendation can be made about which circularity initiatives should be implemented. The circular flooring alternatives have a C2C certificate, but the reuse and recycling options are nearly impossible. While the circular flooring does add to TSH as a brand over, the added value to real estate is unknown. For this reason, TSH should not implement the circular flooring alternatives. This does not mean that other circular material implementations would not be recommended. This research would recommend an alternative that was found to add value to real estate or brand, for example a building material that could be reused at the end of its lifecycle, in a truly circular way.

Using the test case of TSH Delft a circular energy solution was tested, an energy neutral building. This research does recommend implementing this initiative because it saves money over the lifecycle of the building and also adds value to TSH real estate and brand. Because the final design of TSH Delft has already been approved, it is not feasible to be implemented in that project but is recommended to be implemented in future projects when included in the design and investment strategy from the beginning.

This research also recommends implementing the circular water initiative tested, capturing and reusing rainwater for toilette flushing and plant watering. The business case for water reuse is difficult in the Netherlands because the cost of water is low and payback periods are very high. Nevertheless, rainwater capture, and reuse adds value to real estate and brand while helping to the future proof of the building. Same as for the energy initiative, TSH Delft is too late to implement this initiative but it is recommended for implementation in future projects when included from the beginning.

Recommendations for engineer and build

Find suitable partners

Tender contractor to meet the circularity goals of TSH. Maybe link fee to ability to meet expectations.

Recommendations for opening

In this final phase of the development cycle recommendations include:

Measure resource use

As was implemented for existing buildings, measure resource use for new developments. In this way TSH can understand how their development efforts influence their operational resource needs. It is also possible to further reduce resource use from a baseline measurement.

Put operational circularity goals into action

Circularity initiatives involving waste or resource use can now be implemented. These should also be communicated per the strategy to guests.

Communicate circularity strategy to guests

Finally, if making an impact on guests and the community is included in the circularity goals, this should be communicated. TSH has the opportunity to speak directly to thousands of guests and visitors every day, providing them a platform to communicate their circularity goals and brand story.

9.2 Recommendations for practice

Many of the recommendations provided to the graduation company can also be applied to practice in general. The graduation company has the benefit of being both a real estate developer and a hotel operator, in this way they can benefit in the operation phase from decisions made in the development phase. Some additional recommendations can be provided to the real estate and hospitality industries.

For real estate industry

Define circularity in the built environment

With conflicting literature on circularity in the built environment it is hard to find a consensus on what it means. This makes it difficult to be implemented. This research concludes on a circular built environment but one definition it is not widely accepted. This makes it unclear to practitioners, promoting a unified definition would make it easier to implement and find alignment as an industry.

Circularity in the built environment needs to be defined in order to make it tangible and attainable. Without a definition, there is a risk that circularity, like the term “sustainability”, will become generalized and overused without any actual progress being made in the industry. This was already seen in case studies, with hotels and manufacturers making claims for circularity that did not meet the definition of circularity defined in this research. Furthermore, without defining circularity in the built environment it is impossible to measure. Measure measurement and benchmarking is necessary to make progress towards a goal. The definition for a circular built environment is universal. The initiatives and considerations for implementation are not. The same way that sustainability in the built environment has evolved, so will circularity. For now, it means being resource neutral, but maybe in the future it can be resource generating as with energy or water processing. The room for innovation is endless in an effort to continuously evolve.

Measure circularity in the built environment

After defining circularity in the built environment, it should be measured. The way that the C2C certificate measures circularity of products, a building level circularity measurement would support the implementation of circularity. For example, this could be measured in the three categories used to evaluate circularity in this research; materials, energy and water. Energy should be measured using actual building energy use such as energy used per square meter, as the current regulations use EPC

certificates that measure predicted energy use. Water can be measured by purity level of input and output to ensure the building is not degrading the purity of the water it uses. Materials are more difficult to measure because there are many different variables. When measuring circularity of materials inputs should be considered as illustrated by the 9-R framework but also outputs, can the materials used to be used again? Are they durable enough to be used for a long time? All three measurement methods require further research.

Include hotels as key component of sustainable area transformation

Hotels are already an important component to mixed-use development. By providing public space and reaching many people every day from guests to visitors they represent the perfect platform to communicate and represent a sustainable area transformation. Especially with the increase in private-sector led development, hotel developers have become crucial to the puzzle of a complex sustainable mixed-use area.

For hospitality industry

Measure resource use

One of the challenges found in this research was that hotels do not currently measure, or accurately measure their resource use. An accurate measure of resource use allows for hoteliers to see where the savings potentials are, and measure changes compared to a baseline. To be able to reduce resource use a baseline measurement has to be taken.

Work together to find urban solutions

Just as the Circular Hotel Leaders Group has done, the hospitality industry should continue working together on circular solutions. Beyond real estate initiatives, hotels can work together to ask for circular products from suppliers, like mattresses, bedding, or furniture. Hotels can also connect to the larger urban network to implement strategies such a PV cells on a distance for generating additional electricity or partnering with urban greenhouses source local food. Looking beyond their own plot provides additional opportunities for hotels that should not be overlooked.

9.3 Recommendations for policy

The recommendations for policy apply beyond hotel real estate to all real estate where the goal is to develop a sustainable urban area. Law makers can use the tools of regulating, stimulating and capacity building to facilitate sustainable area development include circular hotels.

Mandatory materials reuse

Currently there are no regulations on material use. This provides no incentives for the real estate industry or hospitality industry to reduce or reuse materials. As seen with energy regulations, industry is often forced by regulation only and if the Netherlands wants to reach their vision for a circular future, they also need to provide regulations to do so. The EU has developed a voluntary reporting framework, Levels, to improve the sustainability of buildings with the goal of reaching environmental policy goals. Levels "encourages life cycle thinking at a whole building level and supports users all the way from design stage through to operation and occupation of a building" (Dodd et al., 2017). Making this voluntary reporting mandatory would reduce material use and transition the Dutch built environment to a circular one.

Mandatory water management

Water is abundant and cheap in the Netherlands. This gives both the real estate industry and the hotel industry little incentive to improve upon traditional water management techniques. Encouraging circular water management through regulation is needed to reach the Netherland's vision for a circular future. Recommended regulations include putting the right price tag on water, as proposed by the European Commission. Adequate water pricing acts as an incentive for the sustainable use of water resources. Additionally, the European Environmental Agency proposes non-pricing mechanisms to reduce water consumption including reducing leaks and promoting the installation of water efficient devices (European Environment Agency, 2017). Adoption of these policies in the Netherlands could promote reduced water use and investments in water reuse.

Cost of electricity and water

Through the test cases at TSH Delft it was seen that reduction in energy use is possible, and so is reusing rainwater. Both of these initiatives are difficult business cases because the cost of water and electricity are so low in the Netherlands. Hotels are willing to invest in circular initiatives but a payback period of over 10-15 years is discouraging. Therefore, the regulations should incentivize the transition to a circular built environment by increasing the cost of energy and water or providing funding for investments in reduced energy and water use.

Flexibility in regulation

Through the test case at TSH Delft an internal discrepancy was seen within the municipality. On one hand, the city provides a zoning plan that TSH must abide by. On the other hand, the municipality asks TSH to reach a certain energy use requirement. It is difficult for TSH to do both, and their energy use could be reduced if they were allowed to alter the zoning plan. The municipality should work with companies trying to do the best thing for the community and allow some flexibility if needed.

9.4 Recommendations for future research

During this research, many other opportunities for future research arose due to the level of uncertainty surrounding the topic of circularity, and the rather recent adaptation of circularity in the built environment and in hotels. First, this research could be carried out and applied in different contexts. Looking into circularity in different countries might provide different implementations. Certainly, the test cases would yield different results and materials, energy and water and valued differently around the world.

How to influence user behaviors

One challenge that came up again and again in this research was user behavior. While real estate managers are working towards a circular hotel, it will mean nothing if user behavior does not change. The cases studied in this research are all thinking about how to communicate their message to guests and how to strike the right balance between guest comfort and resource efficiency. Further research can be done into what messages best influence user behavior.

How to measure circularity

As mentioned in the recommendations for industry, circularity needs to be measured. Many solutions for generating energy use raw materials for equipment such as solar panels, which require energy to produce. What is the break-even point for this? Additionally, what matters when it comes to material circularity? Is it more important that a product be recyclable or durable? Further research can be conducted on how this is best done, what measurement tools to use and what should be measured.

What adds value to buildings over time

The longer a building lasts the more circular it is. But this is not the case for all buildings, and some are torn down after just 20 years. Further research is needed to understand what allows a building to stand for 100+ years, not contributing waste but being continuously reused with increased value.

Relationship between adaptability and exit value

One of the considerations discovered in this research is the potential relationship between a hotel's adaptability and exit value. This relationship was questioned in multiple case studies, with the developer predicting that developing a hotel to be easily adaptable for a future use, such as a senior living facility, provided a higher exit value. This relationship was hypothesized on, and further research is needed to understand if there is a positive correlation and if so, what is the additional value of an adaptable building.

Investors willingness to pay for sustainable buildings

Throughout this research, one of the most difficult questions regarding circularity investments that kept surfacing was "are investors willing to pay for it?". There is some evidence as investors begin to require participation in GRESB. Research into the sale of sustainable buildings can provide insight into their value. It is hard to prove that sustainable buildings have a higher value right now, but it is generally thought to be so.

10 Reflection

The aim of this chapter is to reflect upon the process of this research. The reflection includes points on research topic, process, methods, graduation lab, relevance and dissemination.

10.1 Research topic

10.1.1 Position within graduation laboratory

This research was conducted within the 'Sustainable Urban Area Transformations" graduation laboratory under the theme of Urban Development Management. The Urban Development Management graduation handbook stated about this graduation laboratory, "…this theme supports more applied research questions about financial instruments and sustainability measures, as well as more fundamental questions about sustainability in existing urban areas" (2018). This research added to the existing body of knowledge on sustainable urban area transformations by focusing on circularity, a form of sustainability, in hotel real estate. Hotels, similar to other commercial or residential real estate contribute to an urban area as a whole.

In transforming an urban area, hotels can even act as catalysts or anchors for future development. This was the case in all three case studies explored in this research and is also true for the real estate of the graduation company. For example, The QO Hotel is located in a previously industrial area of Amsterdam, and with the help of the developers of the hotel, the area has been rezoned by the City for sustainable mixed-use development. Additionally, hotels provide space for the public and can inform them about an urban area's intentions. This is true for the Hotel Jakarta where entire ground floor space is open to the public and provides dining and recreational facilities to a primarily residential area.

Lastly, the research is applicable beyond hotels to real estate in general. The beginning of this research explores the topic of circularity and circularity in real estate that could be applied more generally. The recommendations chapter of this research includes recommendations for the real estate industry and policy that can be applied to the development of sustainable urban areas.

10.1.2 Position within Urban Development Management

The theme of Urban Development Management concerns the intersection of place, product, person and process as seen in figure 10.1 (Urban Development Management graduation handbook, 2018). This research investigates the role of the real estate manager to implement circularity specifically in hotel buildings. For this, research was conducted into the way real estate managers build networks and use tools for implementing change. Circularity in the built environment is a concept that takes time and effort to implement, and the body of research on the subject is still growing and needed to have a better understanding of how to implement. This research furthers that body of knowledge by looking at an actor (the real estate developer), their process for implementing a product (a circular hotel), in an urban setting.

Figure 10.1: Urban development management (Urban Development Management graduation handbook, 2018)

Additional actors seen in this research include the national and local government who use strategies such as capacity building, stimulating and regulating to steer towards desired outcomes in a given area. As shown in chapter 8, public actors are moving towards more of a facilitating role, and this was seen through case studies as well. In the case of Hotel Jakarta, the developers were incentivized by the municipality of Amsterdam to develop a building with a high sustainability level because it was a requirement of the tender. Therefore, the municipality used their tools as managers towards a sustainable urban area transformation.

10.1.3 A new perspective

From when I first heard of the term circularity, I was skeptical of its value. I have been working on the topic of sustainability in the built environment for several years, but circularity seemed too vague to me to actually add value to sustainability. So much so that I even turned it down as a concept for my group's Urban Redevelopment Game. Only four months later I decided to focus my thesis on the subject, but with the caveat that circularity was nothing more than a buzz word for sustainability. Now nine months later, and hour and hour spent researching and discussion circularity, I feel I have a strong understanding of the concept, and what it means for sustainability, especially in the built environment.

During my research, I noticed people casually interchanging the words circular, sustainable, and green. But is something sustainable always circular, is something green always sustainable? The terms are colloquially used interchangeably. This then became my decision to decide if something found in theory or empirical research was really contributing to the definition of circularity that I had agreed to, or was it just sustainable or just green?

After my research, I still agree that circularity stems from sustainability, but I have grown to appreciate it as its own school of thought. I believe it helps to make sustainability more concrete, making it more measurable and setting clearer goals for what is circular and what isn't. When thinking about sustainability it is hard to define a goal, what makes a building sustainable or not sustainable? My personal idea of a sustainable building has evolved beyond a LEED Platinum certification, which I would still consider sustainable but not circular. One of the challenges for circularity is that it is also known by different names, such as C2C. This makes it harder to find a consensus on how to advance the topic. As Sybren Bosch (2017) of the sustainability consultant Copper8 says about the topic, "As long as we are not sharp enough in wild statements being thrown around, circular economy becomes nothing more than sustainability 2.0."

10.2 Research process

The research process was iterative in that I constantly moved back and forth between literature and empirical research, benefiting from the snowball effect where one piece of information or interview leads to another. This led me to adjust my conceptual model and research questions continuously throughout the process. The process and the outcome remained unclear until just the step before, revealing themselves as I moved further through the process.

Working with a graduation company provided the opportunity to be embedded into an organization already working on the topic of circularity in hotels. This was beneficial in providing a test case to take a deep dive into my research and gain a concrete understanding of my tested initiatives. One challenge of working with a graduation company is to remain impartial as a researcher. While working with TSH I remained unbiased by challenging their definitions and actions towards circularity, using my research results as evidence. I strived to lead the expert panels as an outsider, and make recommendations as a consultant, and not a member of the company. Another challenge of completing research within a company is that the research results are most oriented towards the research company. I believe that my research results are most beneficial for TSH because I used a TSH project as a test case and held expert panels with only employees TSH. I do feel that this approach was beneficial for the context of the research, and that recommendations also apply to other hotels considering implementing circularity initiatives. The external validity could be increased by holding an expert panel with representatives from other hotels, or that could be done in further research.

Because my research was qualitative in nature, and I was looking to understand the point of view of internal actors, I made use of the phenomenology philosophy. "The phenomenologist attempts to see things from that person's point of view" (Bogdan and Taylor, 1975, pg 13-14). This approach was used throughout my interviews and case studies to document the perspective of others.

Before the P1 I made a last-minute decision to switch the focus of my research to circularity in hotel buildings and operations. At the time this was an anxious decision for me because of the time I had already invested in another topic. In the end I am very happy I did, I believe I found a subject that is highly relevant in practice and deserves much more research in theory. This was further reinforced by the empirical research in which practitioners discussed their efforts but also described their uncertainties regarding circularity. This was further reinforced by the partnership with the graduation company, TSH, who are invested in this subject.

The time before the P2 and really up until the P3 was when most of the literature review took place. In addition to academic literature, it was surprising to find the number of consultant and professional reports written on the topic. Although these are not reviewed in the same way as an academic paper, I found they showed a more updated view of practice at the moment. Many of the reports I found were written in past year or two, highlighting the interest of practitioners on this topic. Empirical case studies were held until the P3, adding a deep knowledge of practice to the research and providing many further insights to review again with theoretical research.

Following the P3, a partnership with the graduation company added additional relevance to the topic but also provided a case study with which to test my findings. I found this partnership extremely beneficial because I could gain a better understanding of the hotel industry and real estate development in general. Through this partnership I also gained the insights of circularity and MEP consultants who could further help me verify my research.

My mentors at the TU Delft were patient with their time and supportive with their feedback. I appreciate the opportunity to explore my own research subject with their support. Feedback was provided on both content and methods and helped to shape the direction of my research. My mentors at the TU Delft were also keen to present new perspectives to explore and gave valuable feedback in terms of other considerations to include. Their feedback was incorporated continuously with each step of research.

My contact at the graduation company, and many other collogues and consultants, provided extremely invaluable input in the test case and expert panel design. The goal of this part of the research process was to gain practical insight so this feedback helped significantly. I feel that the research benefited greatly by working from within the graduation company, providing direct access to collogues for feedback as needed.

10.3 Research methods

Literature review

The literature review was used to define the main concepts that would later be used in this research. To do so, a broader research on the concepts of circular economy and circularity in the built environment were carried out. From there it was my duty as the researcher to aggregate the information and select a definition for use in the rest of the research. While these concepts were defined for the purpose of this research they are still debated in theory and practice. The literature review also revealed a gap in literature on this topic. Many problems were presented but not many solutions and the connection between circularity and hotels had not been made.

Exploratory interviews

The exploratory interviews provided a great opportunity to explore the topic in practice and further define the gap in research. These initial interviews allowed me to freely explore the topic and engage with practitioners, leading to potential case studies and contacts for in-depth interviews. In addition, having these informal, enthusiastic conversations was motivational to continue on with my research.

Case studies

The case studies used were selected because they are front runners in the hotel industry. This makes their unique qualities valuable to learn from. The use of case studies in this research was intended to gather all qualities which make them unique in the theme of circularity. Initially a fourth case study was begun, but after an initial interview it was seen that this case did not provide significant additional information to the first three cases, I decided that the case study research had been saturated. In an effort to get a complete picture of every case study, the method of triangulation was used, wherein multiple actors from each case were interviewed. As the research progressed, there were questions I wished I had asked the interviewees, and in some cases I was able to get clarification through another interview, but this is part of the research process.

Test case

From the case studies a list of circularity initiatives that had already been implemented was made. To further understand the differences between the circular initiatives and a traditional initiative the test case of TSH Delft was used. Because this case is in development by the graduation company, I was able to gain first hand insight into the project including quantitative data that I did not have access to during case studies. Once the differences between a traditional and circular initiative were understood, I was able to use this information as the basis for a conversation about the strategic and operational considerations for implementation.

Expert panel

For the discussion on strategic and operational considerations of implementing circularity initiatives I assembled two expert panels made up of employees of TSH. One panel could provide strategic considerations while the other could provide operational considerations. Additionally, the expert panel provided a third opinion to validate research findings. My intention for the panel was to act as an independent researcher wherein I made an effort to lead the panel in an un-biased manner and to allow the panel to discuss the topics amongst themselves. It was difficult not to interject with my own research findings but that was not the intention of the panel. I found this an insightful opportunity discuss each actor's concerns about the circular implementations.

In general, I feel that the research methods began very broadly in an exploratory way to find the gap in literature and practice. From here, research became gradually more specific through the literature review. The case studies and in-depth interviews were even more refined research leading to the most granular research of testing circularity initiatives with the test case. This is the most refined research moment, using background knowledge gained from the steps before to get a tangible understanding of circularity in practice. The expert panel could then use these tangible examples for discussion but also speak again about circularity as a concept. This led to recommendations regarding the test cases but also more generally for the graduation company, practice and policy. In this way the research process can be visualized in figure 10.2.

Figure 10.2: Research method overview, own image

A challenge I encountered with this methodology was that it remained unclear until just before a step was to be performed. When I originally laid out the framework I wondered if each step would be necessary and what exactly would be needed at each step. As time went on I was able to update the framework as needed and it provided a clear structure to my research. A limitation I experienced with this methodology was the need to conduct additional expert panels. While I conducted two within the graduation company, I could have conducted an additional with people unfamiliar to the case studies to get broader feedback. I could have proposed this on my own in the expert panel design, but I did not see the opportunity for it within the methodology framework.

10.4 Ethical dilemmas

Prior to the P2 presentation, I filled in the "registration form for human research by students as part of regular courses" check list. The intention of the checklist is to ensure no harm is caused to interviewees, and all questions were answered "no". Bryman (2012) shares the Framework for Research Ethics. This framework was reviewed, and this research complies with all aspects. One such aspect is that information should not be shared beyond the initial consent given. All interviewees were informed of the

intent and nature of this research, and that any information they shared with me would be publicly shared. No one who participated in this research appeared to have a problem with this and willingly and enthusiastically participated in the research.

10.5 Research relevance

Scientific relevance

This research adds to the existing body of knowledge on circularity, circularity in the built environment and specifically circularity in hotel buildings and operations. This research aimed to fill the gap in literature by illustrating how the hospitality industry can meet the goals of the Paris Climate Agreement by implementing circularity initiatives. This research begins to fill this gap by providing solutions but also making recommendations to future hotel real estate managers on what to consider when implementing circularity. As the research on this specific topic was extremely thin, this research can also provide a base for future research.

Societal relevance

Climate change effects everyone, therefore every industry should investigate how it can contribute to emissions reduction. This research provides recommendations and examples to the real estate industry as a whole but also specifically the hotel industry on how to do so. This research supports the initiatives Paris Climate Agreement and the Netherlands Vision for a Circular Economy by 2050 by making the topic of circularity more concrete and offering suggestions for implementation. The societal relevance is the implementation of circularity in hotel buildings and operations which could lead to lower emissions and reduced resource use.

Sectoral Relevance

Progressing the theme of sustainability in the built environment, circularity offers a more tangible solution to the negative environmental externalities of real estate and hospitality industries. As the hype around circularity grows, and governments are presenting agendas on it, all sectors need to act to reach the outlined goals. This research helps to provide clarity to the definition of circularity in real estate and how it can be implemented in hotel buildings and operations. Both the real estate and hotel industry suffer from having too many standards for a sustainable product, this research on circularity helps to solidify it by asking for closed material loops, energy neutral buildings and complete water reuse.

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Appendix 1: Glossary

Abbreviation	Term	Definition
BAMB	Buildings as material banks	The BAMB project is funded by the European Union and aims to increase the value of building materials by promoting materials passports and reversible building design. BAMB's materials passports are designed for materials, products and systems and to understand the value for recovery or design for disassembly (BAMB, 2016).
BREEAM	Building Research Establishment Environmental Assessment Method	BREEAM is a method of assessing, rating and certifying the sustainability of buildings. The standard is published by the Building Research Establishment (BRE) in 1990. Today the Dutch Green Building Council (DGBC) operates BREEAM NL in the Netherlands (BREEAM, 2016)
	Circular economy	A framework for an economy that is restorative and regenerative by design (Ellen MacArthur Foundation, 2015)
CSR	Corporate Social Responsibility	the voluntary activity of a company to pursue goals that are beneficial for society beyond those required by government legislation (Dahlsrud, 2008)
ESG	Environmental, Social and Governance	ESG stands for Environmental Social and Governance and refers to the three key factors when measuring the sustainability and ethical impact of an investment in a business or company. Most socially responsible investors check companies out using ESG criteria to screen investments (Nordqvist, 2018)
GRESB	Global Real Estate Sustainability Benchmark	GRESB is an international industry-driven organization that addresses the ESG performance of real assets including real estate portfolios and infrastructure assets (GRESB. 2019)
GPR	GPR Gebouw (software)	GPR is a sustainable construction measurement methodology, born from a clear vision of sustainable building: create the highest possible quality with the lowest possible environmental impact.
	Investment strategy	A strategy, or plan of attack, an investor uses when deciding how to allocate capital among several options including stocks, bonds, cash equivalents, commodities, and real estate. The strategy should take into account the investor's tolerance for risk as well as future needs for capital (NASDAQ, n.d.)

LEED	Leadership in Energy and Environmental Design	A certification and rating system used to measure sustainability in buildings since 2000. The system awards credits to buildings that meet it's requirements in seven categories of construction and operation practice (Walsman et al., 2014)
	Sustainability	Sustainability focuses on meeting the needs of the present without compromising the ability of future generations to meet their needs. The concept of sustainability is composed of three pillars: economic, environmental, and social—also known informally as profits, planet, and people. (Kenton, 2019)
TSH	The Student Hotel	Graduation company
	Urban (area) development	A way of working in which government bodies, private actors, and other actors involved reach an integration of planning activities and spatial investment, eventually resulting in the implementation of spatial projects (Daamen, 2010)

Appendix 2: Interview references

Exploratory interviews

Boer, W. (2018, November 22) Partner, CREM

Çatalgöl, M. (2018, February 4) Technical Development Manager, The Student Hotel

Griffin, R. (2018, November 21) Consultant, Building for Tomorrow

Houlman, H. (2018, November 23) Research and Development Manager, CitizenM Hotels

Karsten, F. (2019, January 18) Sustainability Advisor, The City of Amsterdam

Lesimanuaja, P.(2018, November 21) Sales and Marketing Manager, Hotel Jakarta

Mastboom, B. (2018, November 21) Consultant, Building for Tomorrow

Van Anken, S. (2018, November 15) Manager, The Greenhouse Restaurant

Van Zomer, M. (2018, November 15) Owner, 100% Your City Hotel

The QO Hotel

Bueno de Mesquita, X. (2019, January 23) Partner, Amstelside B.V.

Wenneker, P. (2019, January 23) Director and Partner, 4Building

Zeeman, J. (2019, February 5) Management assistant, QO Hotel

Hotel Jakarta

Griffin, R. (2018, November 21) Consultant, Building for Tomorrow

Lesimanuaja, P.(2018, November 21) Sales and Marketing Manager, Hotel Jakarta

Mastboom, B. (2018, November 21) Consultant, Building for Tomorrow

Milius, M. (2019, March 21) Fire safety and building physics advisor, DGMR

Conscious Hotel Westerpark

Heeringa, K.(2019, February 13) Controller, Conscious Hotels

Milius, M. (2019, March 21) Fire safety and building physics advisor, DGMR

The Student Hotel

Abmon, J. (2019, March 14) Intern, Innovation Lighthouse

Çatalgöl, M. (2019, March 5) Technical Development Manager, The Student Hotel

Kempinga,R. (2019, March 12) Director of Hotel Openings, The Student Hotel

Koot, M. (2019, May 22) Project leader, Bectro Installatietechniek BV

Muis, J. (2019, April 12) Director of Asset Management, The Student Hotel

Oosterhof,R.(2019, March 11) Chief Real Estate Officer, The Student Hotel

Rijckmans, L. (2019, May 17) Chief Corporate Services, The Student Hotel

Thellier, N. (2019, April 28) Design Director, The Student Hotel

van de Haar, A. (2019, March 14) Head of Technical Development, The Student Hotel

van Pinxten, (2019, March 12) Procurement Director, The Student Hotel

Westerborg, A. (2019, March 11) Impact Manager, The Student Hotel

Wray, H. (2019, March 21) Research Director, Innovation Lighthouse

Appendix 3: Circular Hotels Leaders Group

CIRCULAIR HOTEL IN DE STAD

KANSEN EN STAPPEN

A. Kamers
- Bedlinnen is ongebleekt en duurzaam gecertificeerd
- Bedden, vloerbedekking en lampen blijven eigendom van de producent
- Bedden en meubilair te repareren, demontabel en herbruikbaar
- Meubilair en (vervangbare) tapijttegels van gerecycled materiaal
- Circulaire afspraken bij inkoop worden vastgelegd en gecheckt
- Er zijn afspraken over het recyclen van afgedankte matrassen
- Informatie in de kamer maakt gast enthousiast voor circulaire aanpak

B. Keuken
- Minder vlees: van dierlijke naar plantaardige eiwitten
- Meer lokale groente
- Inkoop van onverkochte groente en fruit via een 'Food Rescue Centre'
- Korte lijnen met leveranciers: overleg en samenwerking
- Vergeten groente en vlees op het menu
- Verkoop overgebleven maaltijden aan de buurt via een app
- Scheiding monostromen voor hergebruik in nieuwe producten

C. Restaurant
- Geen ontbijtbuffet, maar ontbijt a la carte
- Menukaart vertelt het circulaire verhaal
- Gebruik van kraanwater

D. Management hotel
- Circulaire ambities passen in visie, missie en waarden van het hotel
- Een circulaire scan biedt inzicht in impact, kansen en prioriteiten
- Het team voelt zich onderdeel van de circulaire ambitie
- Actieve samenwerking met andere hotels en gemeente

E. Inkoop
- Circulaire inkoopkracht door samenwerking met andere hotels
- Contract duurzame linnenverhuur en wasserij
- Samenwerking met toeleveranciers op inkoop diensten, inzet gerecycled materiaal, voorkomen verpakkingen en monostromen
- Overleg en afspraken met afvalverwerkers over inkoop en verwerking
- Beperking vervoersstromen door samenwerking logistieke hub
- Transport over water beperkt vervoersbewegingen

F. Receptie
- Vertelt het verhaal en maakt het zichtbaar
- De gast kan meedoen; duurzaam gedrag wordt beloond
- Vervoer van gasten via elektrische taxi, fietsen en elektrische scooters

G. Facilitaire dienst en Technische dienst
- Zorgvuldig gebruik van linnengoed verlengt de levensduur
- Schoonmakers zijn actief betrokken bij de circulaire aanpak
- Gebruik van gerecyclede bedrijfskleding
- Onderhoud met tweedehands onderdelen en materialen
- Continue monitoring van het energie- en waterverbruik

H. Daktuin / groen dak
- Groen dak voor waterberging en biodiversiteit
- Productie van eigen groente en kruiden
- Daktuin met bijenhotel
- Daktuin is toegankelijk voor de buurt

I. Afvalscheiding
- Scheiding monostromen voor hergebruik in nieuwe producten, zoals verwerking sinaasappelschillen en koffiedik in hotelzeep
- Vervoer schone afvalfracties via retourlogistiek hub en leveranciers
- Periodiek overleg met afvalverwerkers over hergebruik en recycling
- Samenwerking afvalscheiding met de buurt

J. Energiegebruik en -opwekking
- Energiebesparend klimaatbeheerssysteem
- Inkoop groene stroom uit Nederland
- Energiegebruik hotel en kamers is zichtbaar voor de gast
- Gast kan energiegebruik kamer vergelijken met de gemiddelde gast
- Eigen energieopwekking hotel door zonnepanelen, WKK, warmte-koude opslag

STAPPENPLAN

01

Sluit aan bij je missie

Waarom wil je circulariteit en hoe sluit dit aan bij jouw identiteit?
Een visie die bij jou past is herkenbaar voor je medewerkers en voor de gasten. Daar kun je op terugvallen. Kostenbesparing is een mooie bijvangst, maar kan nooit het hoofddoel zijn.

02

Breng je kansen in beeld

Door een circulaire scan uit te (laten) voeren wordt duidelijk welke onderdelen in de bedrijfsvoering de grootste impact hebben op het milieu. Gebruik dit inzicht om gericht naar circulaire kansen te zoeken waarmee je echt een verschil kunt maken.

03

Spreek niet van afval, maar van grondstoffen

In een circulaire bedrijfsvoering is het hotel is geen producent meer van afval, maar de eigenaar van (secundaire) grondstoffen. Grondstoffen die het hotel kan verwaarden. Door te praten over grondstoffen denk je automatisch na over de herbestemming hiervan.

04

Daag je leveranciers uit op het gebruik van grondstoffen

Via de inkoop kan het hotel sturen op het vrijkomen van grondstoffen en de waarde van deze grondstoffen. Bijvoorbeeld door afspraken te maken met leveranciers over terugname van producten voor hergebruik, over verpakkingen en over de inzet van gerecyclede en recyclebare materialen. En bedenk: wat niet naar binnen gaat, hoeft het hotel ook niet te verlaten. Dat bespaart opslag en kosten.

05

Van Bezit naar Gebruik

In een hotel staan dienstverlening en gastvrijheid centraal. Het is in het belang van het hotel om deze diensten zo goed en zo efficiënt mogelijk te organiseren. Deze manier van denken kun je doortrekken naar de leveranciers van producten. Door businessmodellen gericht op gebruik in plaats van bezit stimuleer je innovatie op de plek waar dit het meeste oplevert: bij de producent/leverancier die eigenaar blijft van het product en de grondstoffen. Efficiency, levensduur en hergebruik varen hier wel bij.

06

Motiveer het team en enthousiasmeer de gast

Door medewerkers actief te betrekken bij de circulaire aanpak kun je ze motiveren. Laat zien hoe een ieder kan bijdragen en sta open voor nieuwe ideeën. Laat gasten zien welk verschil het hotel maakt en hoe de gast en de omgeving hiervan profiteren. Beloon duurzaam gedrag.

07

Doe het samen: binnen de keten, binnen de branche en met de buurt

Alleen gaat snel, maar samen kom je verder. Krachten bundelen, meer invloed en meer impact, daar moeten we naar toe. Samen met toeleveranciers, met inzamelaars, met vervoerders, met de buurt en vooral: met andere hotels.

HOTELS DRAGEN BIJ AAN EEN GASTVRIJE GEMEENTE EN DUURZAME STAD

In de circulaire economie is verspilling verleden tijd. Afval bestaat niet meer; alles is een grondstof en maakt deel uit van een kringloop. De circulaire economie is de noodzakelijke economie van de toekomst. De Koplopergroep Circulaire Hotels onderzoekt samen met de gemeente Amsterdam wat de hotels hieraan kunnen bijdragen en vooral: hoe ze krachten kunnen bundelen. De Koplopergroep bestaat uit twaalf hotels die duurzaamheid hoog in het vaandel hebben en die nieuwe stappen willen zetten. Wilt u meer weten, dan kunt u een e-mail sturen naar: f.karsten@amsterdam.nl

De Koplopergroep Circulaire Hotels: Ambassade Hotel Amsterdam, Amsterdam Tropen Hotel, Conscious Hotels, DoubleTree by Hilton Amsterdam Centraal Station, Hotel Jakarta Amsterdam, Hotel V, QO Amsterdam, Stayokay Amsterdam, The Albus, Mercure Amsterdam Centre Canal District, The Student Hotel, Hotelschool The Hague.

De Koplopergroep Circulaire Hotels is mogelijk gemaakt door de Gemeente Amsterdam, Provincie Noord-Holland en Rijkswaterstaat/VANG Buitenshuis.

Appendix 4: Sustainable Hotels Menu from the City of Amsterdam

Waarom een duurzaam hotel?

► Inspelen op wens van gasten
Steeds meer hotelgasten hechten waarde aan een klimaatvriendelijk verblijf. Deze *responsible consumers* zoeken bewust naar het hotel dat de beste prijs, kwaliteit en service biedt én het milieu respecteert. Een hotel kan zich op het gebied van het milieu onderscheiden en tegelijk meer comfort bieden. Want duurzaamheid en comfort gaan goed samen. Sommige maatregelen, zoals het aanbrengen van een daktuin, geven het hotel een duurzame uitstraling en bieden de gasten iets extra's.

► Besparen op energie
Energiekosten maken een steeds groter deel uit van de exploitatiekosten van een hotel. Door een extra investering in energiebesparende maatregelen kunnen deze kosten worden gereduceerd en kan de investering binnen enkele jaren worden terugverdiend.

► Nationale doelstelling
Nederland staat voor de opgave het energieverbruik en de CO_2-uitstoot de komende decennia sterk te reduceren. Verduurzaming van de gebouwde omgeving is daarvan een belangrijk onderdeel. In de Innovatieagenda Energie beschrijft het kabinet dat zij streeft naar energieneutrale nieuwbouw vanaf 2020 en een halvering van het totale energieverbruik in de gebouwde omgeving in 2030.

► Hoger kwaliteitsniveau behalen
Veel ondernemers ontdekken de waarde van *groen denken*. Zij streven naar een klimaatneutrale bedrijfsvoering of proberen het denken in gesloten kringlopen (cradle to cradle) toe te passen. Op die manier dragen zij niet alleen bij aan een beter milieu, maar brengen ook de onderneming op een hoger kwaliteitsniveau. En dat zorgt weer voor een aantrekkelijke werkomgeving en een bijdrage aan een klimaatvriendelijke stad of gemeente.

► Milieukeurmerk voeren
Deze menukaart biedt een overzicht van concrete maatregelen die leiden tot de bouw van een duurzaam hotel. De menukaart sluit aan bij het Green Key keurmerk, dat is ontwikkeld voor een duurzaam milieubeleid in hotels. Toepassing van de maatregelen op deze menukaart legt de basis voor het behalen van dit of een ander milieukenmerk.

Colofon en contact

De menukaart duurzame hotels is gerealiseerd in opdracht van Dienst Milieu en Bouwtoezicht en EZ van de gemeente Amsterdam. Deze menukaart is onderdeel van de serie menukaarten duurzaam bouwen, die wordt uitgegeven door het Servicepunt Duurzame Energie. Dit instrument helpt ondernemers, architecten, projectontwikkelaars, aannemers en particulieren duurzaam bouw-en in de bouwplannen te integreren. Voor meer informatie en vragen over duurzame hotels kunt u terecht op:

www.amsterdam.nl/ondernemen/horeca/duurzame-hotels/

Voor meer informatie en vragen over de serie menukaarten duurzaam bouwen en over subsidies, belasting- of financieringsvoordelen, kijkt u op:

www.servicepuntduurzameenergie.nl

Isolatie
Duurzaam bouwen begint bij het voorkomen van onnodig warmteverlies. Dat betekent in de eerste plaats goed isoleren. Door goede isolatie wordt het warmteverlies beperkt en is minder energie nodig voor het op temperatuur houden van het hotel. Goede isolatie verdient zich snel terug en is belangrijk omdat deze de hele levensduur van het gebouw meegaat. Isolatie betreft de hele schil van het gebouw, van het dak tot de vloer, van het glas tot dichte geveldelen.

Schilisolatie
De isolatiewaarde van een dichte schil (gevel, vloer, dak) wordt weergegeven met de Rc-waarde. In het algemeen kan de Rc-waarde van de gevel eenvoudig tot 3,5 of 4,0 worden verhoogd. Dak- en vloerisolatie met een Rc-waarde van 4,0 of 5,0 is goed mogelijk. Gebruik, wanneer dat mogelijk is, natuurlijke isolatiematerialen, zoals glas-, steen- of schapenwol.

Isolerend glas
Glas is ongeveer 75% minder isolerend dan een dichte gevel. Veel warmte gaat door het glas verloren. Goed geïsoleerd glas is dus noodzakelijk. Breng daarom tenminste HR++-glas aan. Drievoudig HR+++-glas is nog beter. Zorg daarnaast voor goed isolerende kozijnen. Zonwerend glas zorgt voor het weren van ongewenste warmte.

Energiezuinige verlichting
Verlichting bepaalt in belangrijke mate de sfeer in een hotel. Energiebesparende maatregelen mogen niet ten koste gaan van de lichtkwaliteit en de sfeer. Ongeveer een kwart van het elektriciteitsverbruik van een hotel is voor verlichting. Energiebesparende verlichting bespaart al gauw 20% tot 50% op conventionele verlichting. Energiezuinige verlichting verdient zich meestal binnen drie jaar terug.

Hoogrendementsverlichting
HR-verlichting is uitgerust met elektronische voorschakelapparatuur, een energiezuinige lamp en reflectoren in de armatuur. Het resultaat is een energiebesparing van circa 30%. Aanwezigheidsdetectie voorkomt het continu verlichten van ruimtes waar dat niet nodig is. Aanwezigheidsdetectie is zinvol in toiletten, magazijnen, keukens, toiletten, garderobes en andere plekken die vaak onbezet zijn.

Daglichtbenutting
Daglichtbenutting voorkomt dat er onnodig kunstlicht brandt wanneer de daglichttoetreding voldoende is voor de verlichting van delen van het hotel. Met daglichtregeling wordt de mate van verlichting afgestemd op de mate van daglichttoetreding. Het verlichtingsniveau blijft constant en dit maakt een energiebesparing van circa 20% mogelijk. Tijdens het ontwerp van het hotel kan rekening worden gehouden met daglichtbenutting.

LED-verlichting
LED-verlichting kan goed gebruikt worden in het design van hotelkamers en andere ruimtes. LED-verlichting is energiezuinig, sfeervol en in veel kleuren verkrijgbaar. LED-verlichting kan worden geïntegreerd in het interieur en zorgt voor een extra sfeervolle uitstraling. Daarnaast kan LED-verlichting worden toegepast in noodverlichting en aanduidingsbordjes.

Duurzame warmte en koude
Een fors deel van het energieverbruik van een hotel bestaat uit verwarming en koeling van de kamers en de andere ruimtes. Er zijn echter goede mogelijkheden deze warmte en koude te verduurzamen. Warmte en koude kan bijvoorbeeld geproduceerd worden met warmtepompen en energieopslag in de bodem. Of het hotel kan worden aangesloten op de stadsverwarming als die aanwezig is.

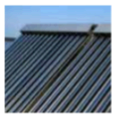
Houtketel of bio-wkk
Een houtketel produceert warmte met houtsnippers of houtpellets als brandstof. Wanneer deze lokaal worden betrokken, kan deze warmteopwekking duurzaam worden genoemd. Een bio-warmtekrachtkoppeling produceert naast warmte ook elektriciteit met (meestal) bio-olie als brandstof.

Laagtemperatuurverwarming (LTV)
Traditionele afgiftesystemen (radiatoren) hebben water met een hoge temperatuur als input nodig om optimaal te kunnen functioneren. LTV kan met een lagere toevoertemperatuur overweg en bespaart daarmee tot 10% energie ten opzichte van een traditioneel systeem. Voorbeelden van LTV zijn klimaatplafonds, betonkernactivering en vloerverwarming. De toepassing van LTV leidt tot een verhoogd comfort.

Energieopslag in de bodem
In de zomer kan warmte in de bodem worden opgeslagen, om het in de winter weer te onttrekken voor de verwarming van het hotel. Ook winterkoude kan op deze wijze worden opgeslagen en in de zomer worden gebruikt voor koeling. Het energieverbruik voor verwarming en koeling kan hiermee gehalveerd worden. Voorwaarde is het gebruik van warmtepompen en laagtemperatuurverwarming.

Stadsverwarming
Wanneer stadsverwarming beschikbaar is, kan het hotel hiermee worden verwarmd. Stadsverwarming is restwarmte uit de industrie of de afvalverbranding. Door hiermee woningen of gebouwen te verwarmen, wordt deze warmte nuttig gebruikt en zo energieverbruik vermeden. Stadsverwarming kan ook gebruikt worden om te koelen. Hiervoor is een absorptiekoelmachine nodig.

Zonnecollector
De vraag naar warm water voor bad of douche is in hotels groot. Zonnecollectoren op het dak van het hotel kunnen het water het hele jaar door voorverwarmen. Hiermee kan tot 50% energie worden bespaard op de bereiding van warm water. Wanneer de vraag naar warm water laag is, kan een boilervat de warmte tijdelijk opslaan. Een zonnecollector kan worden geïntegreerd met zonnepanelen.



Warmteterugwinning uit douchewater
Bij het baden of douchen gaat veel bruikbare warmte verloren. Zonder dat de gasten er iets van merken, kan een deel van de warmte uit het afvalwater worden teruggewonnen. Het warme afvalwater wordt door een centraal opgestelde warmtewisselaar geleid voordat het in het riool verdwijnt. De teruggewonnen warmte kan opnieuw gebruikt worden voor de verwarming van het water.

Materialen
Het gebruik van milieuvervuilende materialen moet worden vermeden. Uitspoelende metalen, zoals koper, lood, zink en nikkel, zijn slecht voor het milieu, evenals composietmaterialen, niet FSC-gecertificeerd tropisch hardhout en andere eindige materialen. Duurzame materialen kunnen worden teruggebracht in de kringloop, tasten de natuur niet aan en worden dichtbij huis betrokken. Soms is het ook mogelijk materialen opnieuw te gebruiken. Het gebruik van prefab componenten vermindert onnodig materiaalverbruik en het aantal transportbewegingen. Het toepassen van Industrieel, Flexibel en Demontabel (IFD) bouwen zorgt voor een reductie van transportbewegingen naar de bouwplaats en optimale ruimtebenutting en flexibiliteit in het gebouw. Het hotel is zo in de toekomst goed aanpasbaar.

Betongranulaat als grindvervanger
Beton bestaat voor een deel uit grind. Grind wordt vaak ten koste van het landschap gewonnen. Het aantal locaties voor grindwinning is daarnaast beperkt. Betongranulaat is een kostenneutrale en kwalitatief goede vervanger voor grind. Betongranulaat wordt gemaakt van afvalpuin en wordt onder dezelfde kwaliteitsgaranties aangeboden als grind.

Ventilatie met warmteterugwinning
Ventilatie is nodig om de lucht in het gebouw te verversen. In de winter wordt koude lucht naar binnen gezogen, terwijl warme lucht het gebouw verlaat. De warmte kan echter voor het grootste deel (90%) worden teruggewonnen met een warmtewisselaar. Dit resulteert in een besparing tot 25% op de stookkosten.

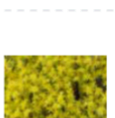
Helofytenfilter
Een Helofytenfilter zuivert afvalwater zodat het niet in het riool, maar op het oppervlaktewater kan worden geloosd. Het filter bestaat uit een zandbed met moerasplanten waar het afvalwater doorheen stroomt. Rondom de wortels van deze planten zuiveren bacteriën het afvalwater van afvalstoffen. Een helofytenfilter is geschikt voor het zuiveren van water dat afkomstig is uit douche, wasmachine en keuken.

Windturbine
Op het dak van het hotel kan een kleine windturbine worden geplaatst. Deze windturbine produceert elektriciteit en kan voor een deel in de elektriciteitsvraag voorzien. Belangrijk aandachtspunt is de plek waar de turbine wordt gepositioneerd in verband met turbulentie. Daarnaast is het verschil tussen de opbrengsten van de verschillende typen aanzienlijk.

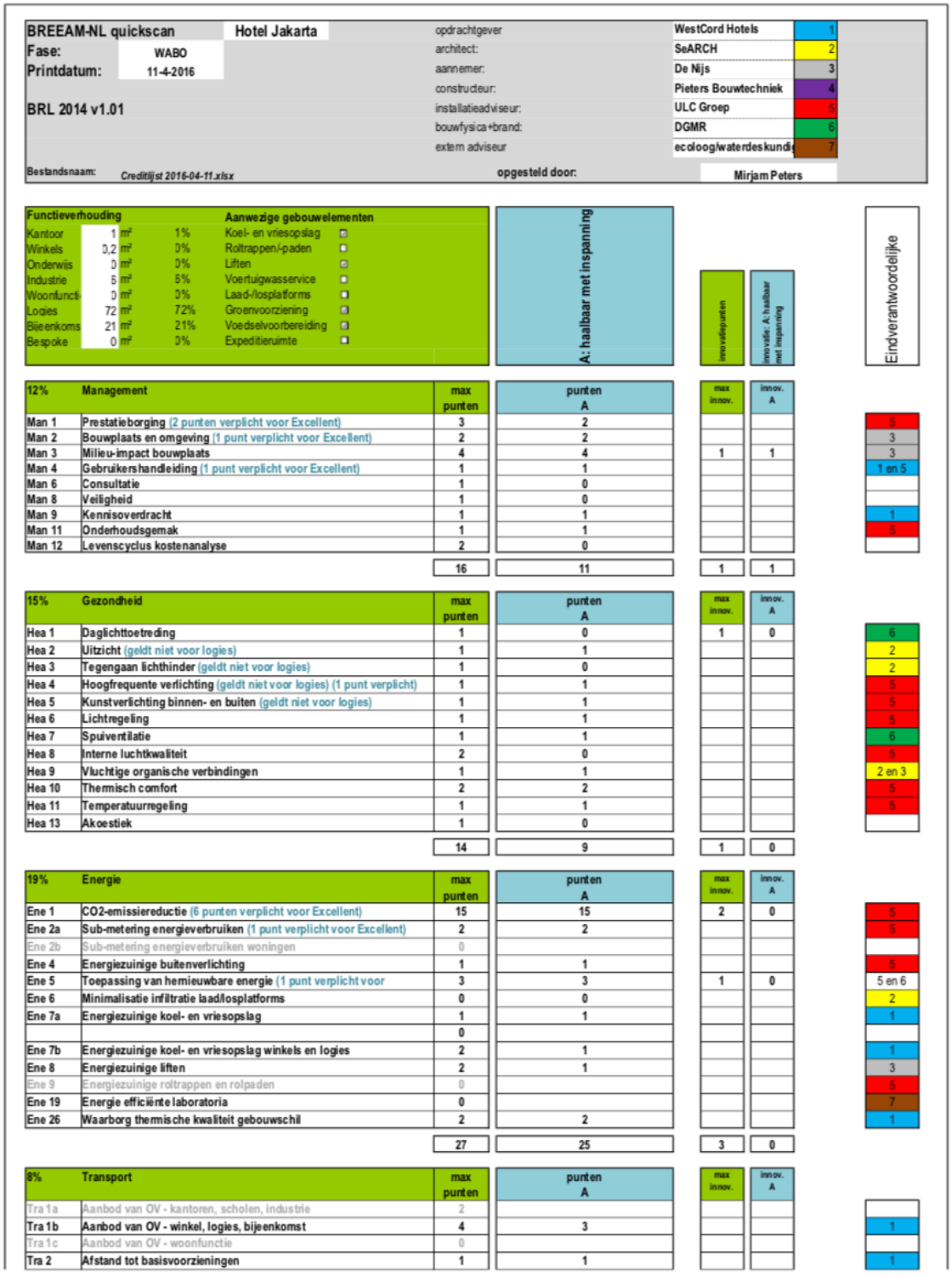
Gebouwbeheersysteem
Moderne gebouwbeheersystemen verlagen het energieverbruik zonder comfortvermindering. Een gebouwbeheersysteem regelt op basis van de aanwezigheid van gasten op kamerniveau de temperatuur, de ventilatie en stand-by elektriciteitsverbruik. Het systeem registreert daarnaast het energie- en waterverbruik. Lekkage of onnodig energieverbruik kan snel worden opgespoord en verholpen.

Zonnepanelen
Zonnepanelen zetten zonlicht om in elektriciteit. Het dak van het hotel is vaak zeer geschikt voor het plaatsen van deze panelen. De zonnecellen kunnen ook verwerkt worden in de gevel of in overstekken. Zonnepanelen kunnen een deel van het elektriciteitsverbruik van het hotel zelf duurzaam opwekken. Zonnepanelen zorgen daarnaast voor een duurzame en moderne uitstraling. Een zonnepaneel kan worden geïntegreerd met een zonnecollector (PVT-collector).

Vegetatiedak
Een vegetatiedak is een begroeid dak met een relatief dunne substraatlaag waarop vetplantjes, grassen en mossen groeien. Een vegetatiedak zorgt in de zomer voor dakkoeling en een vertraagde afvoer van regenwater. Ook kan een daktuin worden aangelegd, waarin de gasten kunnen verpozen. Een vegetatiedak of daktuin heeft een prettige uitstraling en biedt een extra recreatiemogelijkheid.



Appendix 5: Hotel Jakarta BREEAM Application



BREEAM-NL quickscan	Hotel Jakarta	opdrachtgever	WestCord Hotels	1
Fase:	WABO	architect:	SeARCH	2
Printdatum:	11-4-2016	aannemer:	De Nijs	3
		constructeur:	Pieters Bouwtechniek	4
BRL 2014 v1.01		installatieadviseur:	ULC Groep	5
		bouwfysica+brand:	DGMR	6
		extern adviseur	ecoloog/waterdeskundi	7
Bestandsnaam:	Creditlijst 2016-04-11.xlsx	opgesteld door:	Mirjam Peters	

Functieverhouding			Aanwezige gebouwelementen	
Kantoor	1 m²	1%	Koel- en vriesopslag	☑
Winkels	0,2 m²	0%	Roltrappen/-paden	☐
Onderwijs	0 m²	0%	Liften	☑
Industrie	5 m²	5%	Voertuigwasservice	☐
Woonfuncti	0 m²	0%	Laad-/losplatforms	☐
Logies	72 m²	72%	Groenvoorziening	☑
Bijeenkoms	21 m²	21%	Voedselvoorbereiding	☑
Bespoke	0 m²	0%	Expeditieruimte	☐

12%	Management	max punten	punten A	max innov.	innov. A	Eindverantwoordelijke
Man 1	Prestatieborging (2 punten verplicht voor Excellent)	3	2			5
Man 2	Bouwplaats en omgeving (1 punt verplicht voor Excellent)	2	2			3
Man 3	Milieu-impact bouwplaats	4	4	1	1	3
Man 4	Gebruikershandleiding (1 punt verplicht voor Excellent)	1	1			1 en 5
Man 6	Consultatie	1	0			
Man 8	Veiligheid	1	0			
Man 9	Kennisoverdracht	1	1			1
Man 11	Onderhoudsgemak	1	1			5
Man 12	Levenscyclus kostenanalyse	2	0			
		16	11	1	1	

15%	Gezondheid	max punten	punten A	max innov.	innov. A	
Hea 1	Daglichttoetreding	1	0	1	0	6
Hea 2	Uitzicht (geldt niet voor logies)	1	1			2
Hea 3	Tegengaan lichthinder (geldt niet voor logies)	1	0			2
Hea 4	Hoogfrequente verlichting (geldt niet voor logies) (1 punt verplicht)	1	1			5
Hea 5	Kunstverlichting binnen- en buiten (geldt niet voor logies)	1	1			5
Hea 6	Lichtregeling	1	1			5
Hea 7	Spuiventilatie	1	1			6
Hea 8	Interne luchtkwaliteit	2	0			5
Hea 9	Vluchtige organische verbindingen	1	1			2 en 3
Hea 10	Thermisch comfort	2	2			5
Hea 11	Temperatuurregeling	1	1			5
Hea 13	Akoestiek	1	0			
		14	9	1	0	

19%	Energie	max punten	punten A	max innov.	innov. A	
Ene 1	CO2-emissiereductie (6 punten verplicht voor Excellent)	15	15	2	0	5
Ene 2a	Sub-metering energieverbruiken (1 punt verplicht voor Excellent)	2	2			5
Ene 2b	Sub-metering energieverbruiken woningen	0				
Ene 4	Energiezuinige buitenverlichting	1	1			5
Ene 5	Toepassing van hernieuwbare energie (1 punt verplicht voor	3	3	1	0	5 en 6
Ene 6	Minimalisatie infiltratie laad/losplatforms	0	0			2
Ene 7a	Energiezuinige koel- en vriesopslag	1	1			1
		0				
Ene 7b	Energiezuinige koel- en vriesopslag winkels en logies	2	1			1
Ene 8	Energiezuinige liften	2	1			3
Ene 9	Energiezuinige roltrappen en rolpaden	0				5
Ene 19	Energie efficiënte laboratoria	0				7
Ene 26	Waarborg thermische kwaliteit gebouwschil	2	2			1
		27	25	3	0	

8%	Transport	max punten	punten A	max innov.	innov. A	
Tra 1a	Aanbod van OV - kantoren, scholen, industrie	2				
Tra 1b	Aanbod van OV - winkel, logies, bijeenkomst	4	3			1
Tra 1c	Aanbod van OV - woonfunctie	0				
Tra 2	Afstand tot basisvoorzieningen	1	1			1

Functieverhouding			Aanwezige gebouwelementen	
Kantoor	1 m²	1%	Koel- en vriesopslag	☐
Winkels	0,2 m²	0%	Roltrappen/-paden	☐
Onderwijs	0 m²	0%	Liften	☐
Industrie	5 m²	5%	Voertuigwasservice	☐
Woonfuncti	0 m²	0%	Laad-/losplatforms	☐
Logies	72 m²	72%	Groenvoorziening	☐
Bijeenkoms	21 m²	21%	Voedselvoorbereiding	☐
Bespoke	0 m²	0%	Expeditieruimte	☐

			A: haalbaar met inspanning	innovatiepunten	innovatie: A: haalbaar met inspanning	Eindverantwoordelijke
Tra 3a	Alternatief vervoer	2	2	1	0	1
Tra 3b	Alternatief vervoer - woningen	0		1		
Tra 4	Voetgangers- en fietsersveiligheid	2	2			2
Tra 5	Vervoersplan en parkeerbeleid	3	1			1
Tra 7	Vervoersinformatiepunt	1	1			1
Tra 8	Toelevering en manoeuvreren	1	0			
		14	10	2	0	

6%	Water	max punten	punten A	max innov.	innov. A	
Wat 1a	Waterverbruik (1 punt verplicht voor Excellent)	3	2			5
Wat 1b	Waterverbruik - woningen	0				
Wat 2	Watermeter (1 punt verplicht voor Excellent)	1	1			5
Wat 3	Lekdetectie hoofdwateraansluiting	1	1			5
Wat 4	Zelfsluitende watertoevoer sanitair	1	1			5
Wat 5	Recycling van water	1	0			
Wat 6	Irrigatiesystemen	1	1			1
		8	6	0	0	

12,50%	Materialen	max punten	punten A	max innov.	innov. A	
Mat 1	Bouwmaterialen (1 punt verplicht voor Excellent)	8	4	1		6
Mat 5	Onderbouwde herkomst van materialen	4	2	1	0	3
Mat 7	Robuust ontwerpen	1	0			2
Mat 8	Gebouwflexibiliteit	4	1			2
		17	7	2	0	

7,50%	Afval	max punten	punten A	max innov.	innov. A	
Wst 1	Afvalmanagement op de bouwplaats	3	3	1	1	3
Wst 2	Gebruik van secundair materiaal	1	1	1	0	3
Wst 3a	Opslagruimte voor herbruikbaar afval (1 punt verplicht voor Excellent)	1	1			2
Wst 3b	Opslagruimte voor herbruikbaar afval - woningen	0				
Wst 5	Compost	1	1			1
Wst 6	Inrichting	1	1			1
		7	7	2	1	

10%	Landgebruik en ecologie	max punten	punten A	max innov.	innov. A	
LE 1	Hergebruik van land	5	5			7
LE 2	Verontreinigde bodem	2	0			7
LE 3	Aanwezige planten en dieren op de locatie	1	1			7
LE 4	Planten en dieren als medegebruiker van het plangebied (1 punt	2	1			7
LE 6	Duurzaam medegebruik van planten en dieren op de lange termijn	1	1			7
		11	8	0	0	

10%	Vervuiling	max punten	punten A	max innov.	innov. A	
Pol 1	GWP van koudemiddelen voor klimatisering	1	0			5
Pol 2	Voorkomen van lekkages van koudemiddelen	2	2			5
Pol 3	GWP van koudemiddelen voor warenkoeling	1	0			5
Pol 4	Ruimteverwarming gerelateerde NOx emissie	3	3	1	0	5
Pol 6	Afstromend regenwater	3	1			7
Pol 7	Minimalisering lichtvervuiling	1	0			5
Pol 8	Geluidsoverlast	1	1			6
		12	7	1	0	
			90	12	2	

	gewicht	gem. A	innov. A
Management	12,0%	8,25%	1
Gezondheid	15,0%	9,28%	0

Functieverhouding				Aanwezige gebouwelementen	
Kantoor	1	m²	1%	Koel- en vriesopslag	☐
Winkels	0,2	m²	0%	Roltrappen/-paden	☐
Onderwijs	0	m²	0%	Liften	☑
Industrie	5	m²	5%	Voertuigwasservice	☐
Woonfuncti	0	m²	0%	Laad-/losplatforms	☐
Logies	72	m²	72%	Groenvoorziening	☑
Bijeenkoms	21	m²	21%	Voedselvoorbereiding	☑
Bespoke	0	m²	0%	Expeditieruimte	☐

		A: haalbaar met inspanning	innovatiepunten	innovatie: A: haalbaar met inspanning
Energie	19,0%	17,78%		0
Transport	8,0%	5,64%		0
Water	6,0%	4,50%		0
Materialen	12,5%	5,18%		0
Afval	7,5%	7,50%		1
Landgebr & eco	10,0%	7,27%		0
Vervuiling	10,0%	5,83%		0
totale BREEAM score:		71,2%		2
inclusief innovatiepunten:		73,2%		
Excellent vereist voor MIA subsidie		EXCELLENT		

Eindverantwoordelijke

dGmR

Appendix 6: QO Hotel Interview – transcribed

Stakeholder management interview protocol

Interviewee: Philip Wenneker. 4Building, project manager of QO Hotel Amsterdam

Xander Bueno de Mesquita, Developer, Amstelside B.V., Developer of the QO Hotel Amsterdam

Interviewer: Katherine Beisler

Location: QO Hotel, Amsterdam

Survey Sections Used:

A: Interview Background

B: Over the QO Amsterdam

C: Reflection

Introductory Protocol Script (to be read by interviewee)

Good afternoon! My name is Katherine Beisler, I'm currently completing my masters in the Management in the Built Environment program at TU Delft. I am conducting my thesis on how circularity can be incorporated into hotel buildings and operations. The purpose of this research is to understand how pioneers in the hospitality industry have incorporated circularity into their buildings and operations, what the drivers and effects were of these initiatives. I will be recording this interview to later be transcribed into text. No personal information will be collected from you besides your name and position within your company. Please see the informed consent form to grant consent for audio recording the transcribing of the text. Please also specify if you would like to anonymize the interview or if I can use your name in my research report. The audio recording will be kept until the researcher completes her master thesis, expected July 2019.

Thank you for taking the time to talk with me today. The purpose of this interview is to learn about stakeholder management on the QO Hotel in Amsterdam. I have asked to meet with you because of your involvement in the project management of the QO Hotel. For this interview, there are no right or wrong answers, or desirable or undesirable answers. I would like you to feel comfortable saying what you really think and how you really feel. If it's okay with you, I will be tape recording our conversation since it is hard for me to write down everything while simultaneously carrying an attentive conversation with you. Everything you say will remain confidential, meaning that only myself and my mentors will be aware of your answers. The purpose of that is only so I know whom to contact should I have further follow-up questions after this interview.

I have planned this interview to last no longer than one hour. During this time, I have several questions that I would like to cover. So, let's begin.

A. Interviewee Background

K: Can you talk maybe a little bit about your professional background, and how you kind of got to this stage?

P: I studied civil engineering at the University of Delft back in the late 80's early 90's. I worked at a construction company, one of the largest construction companies of the Netherlands, which is now, all BAM. So there were different contractors which took over each other and now it is now called BAM. I worked with one of these companies before. Then, I started at a consultant, a construction consultant, housing and construction consultant, then we were taken over by a large engineering company, Royal Haskoning, so I worked for Royal Haskoning for three years as well, and then I started my own company, 4Building, together with 3 colleges from the old days, before the takeover. And then I met Xander.

Xander: That was at the Royal Haskoning time already.

P: Ya, Royal Haskoning BM, but my boss said well, Xander, don't believe him.

K: With this project, you met for this project?

P: No, not this project, an idea before this project.

X: I forgot about that

P: And I said okay, well, would you mind if I help this Xander a little bit with his ideas on my own time then? Well that was alright, so I did. And then he came with this pitch for this spot. And I helped a little bit. And then I started my own company.

K; Because of this project?

P: No, but I started my own company, but then my boss said, but this project, that is ours. I said okay, maybe you should make a contract then with Xander, so that you are going to work for him. They said okay, they made an offer, and he resigned and it and then he hired me.

K: But then you had to step down from Royal Haskoning?

P: I was already gone. What we do? We do concept developments, we make programs of requirements, we do project management, so design management, project management.

X: So, he is guilty for everything that went wrong.

P: Tendering for consultants, and contractors, we do construction management that kind of thing. So as a consultant and an advisor. We are not a developer ourselves, we are not risk taking in that sense, we are not a contractor as well, we are a consultant and an advisor.

B. Over the QO Amsterdam

K: And so for this project Amstelside hired you to do the project management?

P: and cost consultancy

K: Which stakeholders were involved in the development of the project?

P: There were a lot, so in the project evolving he came with thousands of advisors, consultants and people who should do something for this project, so that was very difficult to manage. So the concept was also developing in these years so every step he made, it gave reason to change something in the advisory team, especially for the interior design. So the interior design has been changing a lot over the years.

K: Was that complicated to manage?

P: It was very complicated to manage, and it was because of the alignment with IHG (intercontinental hotels group) which was difficult so at first, we started as a Crown Plaza. But it wasn't meant to be a Crown Plaza so we had to change the design. Or we made a design which didn't fit into the Crown Plaza look and feel. There was a lot of discussion about this interior design, and we started again, with another interior designer, and that was not good as well, and then we started with another so we had a lot of different designers on this project.

K: Can I Just map the stakeholders, so I've got it?

P: I want to map it for you, but I have to update it. But, I have a version from some time ago. (shows chart) But I have a thing like an organization chart. So, what I think is that we have Amstelside as principle or the developer.

K: But was Amstelside just Xander?

P: No, there were 4 people. With all their own company, being shareholder of Amstelside. Maybe you remember this one (to Xander)? The four people of Amstelside were the boss. They decided on everything. They did the commercial development, the concept development and we decided that pre-opening was a separate strategy. And within these three main organization lines we had subjects like the development, the design and construction, so basically this was my responsibility. Then you have the concept development which Xander was the problem owner of, and I helped him with that and a lot of other consultants did. Then you had the FF&E and OS&E which is basically the fit out of the hotel, which is very important for telling your story.

X: And it is also very important with where the budget is. Basically, because if you split operations and property then it gets very complicated but if you are very smart In this FF&E and OS&E belongs to the operations, and also the budget. And the other one is construction development.

P: It's the asset, the hotel is the asset, the long-term investment. And then you have the short-term investment which is the fitting out of the hotel so this changes more regularly than the building itself. So that's the use of the hotel is the FF&E and the OS&E and the asset is the building.

X: If you say what we had was the property and operations, and you say its 100, I wouldn't say 50/50 but if you have the whole budget the FF&E this belongs to the operations also the value, which is a considerable amount of money, you can play a little with it if you want ot have it over there or over there.

K: So you want to include the FF&E in the operational budget?

X: It is, so if you sell it the value of this building is this thing, its OPCO not PROPCO. This is from operation (pointing to cup) , so 30% is from operation and 70% are I don't know, you can play with that. And it gets very complicated with sustainability things because if this is FF&E and that is construction because that is fixed but it gets very complicated.

P: Then you have the pre-opening which was preparing for operations, so branding and marketing, and the whole opening strategy thing.

X: Which is staff IHC management things, to get this actually going.

P: Procurement, so basically this is the overview of the organization and of the project organization, and then you have the environment, the surroundings, the municipality the neighborhood, so that is not in this chart.

K: External stakeholders?

P: Yeah, external stakeholders.

X: Which is also very complicated because this was a new area so we have been for 3 years or 4 years in project development of the municipality with all the developers, how much should we pay, how much do we get back for public space or whatever, should we start developing or not because it is crisis, it's a whole thing here we…the environment or the thing.

K: Of external stakeholders. But your focus was on the internal stakeholders?

P: As the project manager of this project I was focused on, let's call it the internal project organization. And some people did management by absence in this whole project, so we filled in the gaps that were there sometimes. But formerly this is a description of how it functioned. And I want to make clear which organizations were involved in this project for you, I will do that, not now but I will do that and send it to you.

K: That would be great.

P: Because I need it for something else as well, it's a coincidence. I make a formal one how it should work for you (Katherine) and how it did work for you (Xander).

X: That is great and you can send it to me as well because I am going to use it as a blueprint. And I will cycle away which didn't make sense.

P: I will make the formal one, how it should work for you (Katherine) and how it did work for you (Xander).

X: How it did work and how it should work and how it should work I am going to read that and say no this is not working and I am going to take it along to Bonaire or Portugal.

K: Then did you have to initiate the contract with your interior designer or whoever else was involved commercial development?

P: In the beginning yes and then it changed again at the end of the final interior designer and the negotiation about that contract was done by, I don't know.

X: For me it was what should be his role without knowing how should it work without having a study about it. And especially with an innovative project the hardest part I'm just talking about a team its not very complicated, and you have to pitch stakeholders you don't know a designer and engineer sustainability company For me the most added value by heart, having an independent project manager and he asked what do you want and I can have an independent pitch that's one of the most important and difficult parts of for instance the greenhouse I'm not an expert in greenhouses and neither is he so how do you. And it arrives again for my storyline what do you want to achieve with the greenhouse? And then we have expertise in the Netherlands with the greenhouse but how do you pitch a good contractor, or a good designer depends on what's in my head. And to avoid fuckups like people having different interests to involve their friend. For me that was one of the main reasons to have someone I don't know who's not interested who is not going to make money from choosing a party. I come from casinos as well so you need someone who's helping you out who is not interested in the money side so I pay you. So you need somebody outside.

K: He was like an owner's rep?

P: Yah, so what we tried to do was also to explain to IHG which knowledge we needed from them. So we tried to flip this organization chart to the IHG organization. So we need that guy there and that guy there.

K: You were looking to fill in the gaps.

P: But this was very new for IHG so they tried to give their input over here. And say good luck we want Crowne Plaza and….

X: It's totally different you don't need anything usually, if I go 90% of the time if you're not developing your own brand you're an owner you have a bag of money and a location and you go to a big brand new say ok. and they're going to look and say OK it's in this area You need a Crown Plaza and then you get a book and it's this big and you don't need anything you don't need to design this is what you fill in this is where you buy it and we have the procurement as well because the worldwide thing. In every aspect it was different for the stakeholders because they're not used to it.

K: But now that is done more often with these smaller concepts?

X: But then it gets more complicated because you have a franchisee and a management contract and a few big brands do own but they hardly own the property themselves so what is getting a bigger market is a company, a white label management company and you approach them and say we are in Dubai and I think this area needs...we are going to build it, I know this white label and I know the brand sort of and

we first finish it and then we offer it to, and then you have a white management in between it, and you have interstate, and it gets bigger and bigger and bigger.

All: Discussion about coke

K: Within the project line that you were managing, and the stakeholders that you were managing Can you describe how influential they were? Who brought what specific piece of information or advice?

P: On what level?

K: So the vision was coming from Xander, but did someone else introduce the greenhouse or water pumps?

P: That is a very small question with a very large answer.

K: Maybe you can provide an example?

P: For example, we have here from the beginning until the end an architect which is two companies actually, to make it easy.

X: I am very curious about his answer.

P: At the beginning we started also thinking of new solutions to solve energy issues or this architect is known for his sustainable projects, and design. Paul de Ruiter, and he came up with the idea of the intelligent facade.

K: Perfect, this is a great example

P: He started with the idea of the intelligent facade, we had a lot of other ideas but this one survived, and ARUP the engineering company for the technical installations, HVAC. And they said oh I can do something with that because we have a dynamic insolation.

X: But that came from the architect

P: They had to calculate that. It was calculated by ARUP but the main idea of the facade was brought in by Paul de Ruitter. But at the end they are design solutions answered on the questions, how do I make a sustainable and innovative hotel?

X: So, going back at the beginning, I wanted to have the most sustainable hotel but I didn't know anything. I put up the yellow papers, and said who is the most sustainable architect in the world? I started with William McDonough.

P: He wrote the book cradle to cradle.

X: Okay, and then I found out her was worldwide famous book and development and I found out he was a small architecture firm in the states, so didn't work. So I looked in the yellow pages again and I came to another architect so we won the pitch with them and we said goodbye to him because we or I or whatever were not happy with the cooperation.

P: With his offer.

X: And we finally came with an architect where I was really feeling happy with, he understand what I want and he said I have a long time vision of a part of the sustainability of a living building and I wanted to execute it for a long time and it's called a chameleon skin and we probably need this and this engineer company which was ARUP one of the biggest engineers in the world, and it came in my perception from the story line what is a sustainable hotel and why would you want to do it? He was basically the 3rd architect and besides all this procurement and all this theoretical things, what I got happy about was I could communicate about innovation and sustainability but his specialty was architecture. But the most important thing and especially lessons learned, and I was happy with him, you need all those stakeholders, and they won't take the risk to dive into an innovative process. Whether you are financial, economic, designer, engineer or whatever comes if they don't have that urge of okay we have to go that way and tell me what you know, what is your specialty, and help me out with it. Because I don't know that.

P: So we have a lot of people and companies involved. I can tell you for many hours about all the consultants, advisors and contractors.

X: And for instance, the concept, the hardcore design concept obviously we asked the usual suspects to help us out, like engineer company but Wageningen and Delft and that was the moment that there was very good energy, especially with young women in the Netherlands who challenged the status quo. So, there were a few disrupters, young girls with companies who are 7 years later the authority on circularity. For instance, you had a professor of circularity, Grietje from Wageningen, and I think it helped a lot to have the disturbers or innovators in this process and you could only do that in my role, I am very impressed with you as a professor and as big a company as ARUP but I need something else.

P: The difficulty in this project was actually until what point do you allow innovation? How do you cope innovation after that moment and how do you incorporate new ideas in a project which is ongoing? That is very difficult.

X: And I have the solution and that is a different way of project management.

K: Can you maybe give an example?

X: I can give you a very concrete example, the greenhouse, we had a vision, living building, it's a principle you can look it up. You have the 4 loops, water, energy, C02 and waste, and you want to solve that, and the theoretical idea is you need a green leaf in that. So, let's make a greenhouse. Added value, we happen to live in the Netherlands we, we know a lot about greenhouses, so cool. We thought of it, my architect in Holland he is not a greenhouse builder and ARUP is either and he's not and I'm not so how do you do it. It was a whole process, and, in the end, we found somebody who could do it. Here we are 2 years later, and we had to innovate again. The thing that went wrong in my perception in an innovative process you have to be as flexible as possible, to make it concrete, the greenhouse costs about 800 thousand euros if you have a team who is really into how do you connect it to a building and make it circular, or whatever, new, innovation, also for them, you say I guess, it will cost 800,000 euros. But it's an innovative process so it has to be as flexible and adaptable to new innovation as possible. So, the budget is 800,000 we start making something which costs 200,000 euros. And especially with them, have new kids on the block involved in an innovation process, because we are the best in agriculture, and the

question developed in the last 60 years, coming to the people in the west-land and Wageningen, the question was coming from the food industry so they didn't ask can you develop a sustainable tomato for bla bla bla they said I'm coming from the food industry so I want to have a tomato which is red, round and can be refrigerated for 6 weeks and can be traveled. And a university said of course I can solve the problem. And with that knowledge I said I am going to ask you a different question. So, in an innovative process I think and it has to do with design thinking and whatever you have to approach it differently because standard developers and people who did it say okay you build something you have to have a budget and you have a timeline and you have guarantees and you have maintenance and whatever what does a standard line it's not going to work with innovation because you have to be able in timeline in budget to make mistakes.

P: so, what is he basically saying is that you have to create space, flexibility space when you're innovating.

K: and budget space?

X: Well that's the same here. You need space and time and budget do you say it's 100 and we start with 50 and we have a timeline of 50 to prove this facade is working because I didn't buy a facade with steel and glass I bought something as a service because if we would have done it correctly somebody said if you do this it's going to save 65% of energy and I said ok cool and halfway they say you can't take me as accountability because if you put heating on over there. You just sit around and process and say are you going to take the same responsibility? Now everybody saying that but you can't ask them if it's water resistant, it's very hard, you could have done it.

P: I can a little bit understand what you're trying to say but I think for her (Katherine) it's a little bit difficult.

K: You are talking about innovating on the facade?

P: What you trying to say is we last not a thing but a quality so if we ask a question in a different way and made different contracts but the one who built this facade we stretch his intelligence and his innovative strength to create something which meets this requirement.

K: Is that what happened are you saying that's what you wish happened?

X: It happened a little bit but If lessons learned. In your first question was if I would do it again that's what I said very roughly to him I have a different type of project management because the standard project management does make sense it's very specific because you always do it and it's a proven concept so you can put a guarantee on it and maintenance and very complex things like Escos and whatever you have to realize at the beginning of the project management everybody has to be ready for it and the core thing.

P: That's very important, the market must be ready for that

K: For things like a product as a service or paying for quality?

X: Obviously we've been doing that I started with an Esco. Basically, if you were asked me as a crazy guy and people came to me and said I will make an Esco for you. But then a sailing partners or whatever they knew there was a real good business case in it because 90% of the office buildings make a lot of money

because for me its very easy to make it a little bit more sustainable and then they looked at my building and realized it's very hard for me to make money on it as an Esco because I don't want the cold heating storage I want to service and you can own stuff.

P: But the money was not a problem over here, so the investment was not a problem. Which is a driver for making Escos or instance.

K: I don't know what an Esco is?

P: It's an energy as a service company.

P: So the Enecos or the large energy companies invest in the hardware and they provide heat or cooling the building and you pay for kilowatts.

K: And you're saying that it's how are you that's how you wanted it to work?

X: Now this is a development one of the development and sustainability which big companies are picking up and it's getting very complicated you want to have a service he wants a product he's responsible for the product and you say just like a management agreement I'm going to pay you for the first 25 years for a service so you got a very steady income and not one time a bag of money and then in the middle you have the financials and they don't understand on which. I have a very good example of where it did more or less work and it's a carpet company one of the biggest in the world and in my perception it's the most circular company in the world and I've been with them going to banks to explain it so what it is we have a carpet company and it should be a lease contract you make the product owner or developer responsible for his own product so also for the beginning of the cycle and the end of the life cycle and you say I want to have the service of a carpet which means you have to clean it you have to do everything in when it is worn out you take it back in your loop. And they're very far with it and Philips is very far with it but not far enough. I think if I would do it again now and I would do the project management with him and I really challenge the market I would be able to do it totally because banks art ready for it. We were too early for it. So, some parts work and a lot of parts didn't work yeah Philips is not there.

P: And the scale is too big and too complicated. So, it's better to start this kind of service contract with a less complicated project I think. You should be able to practice a little bit before you do something like this.

K: Were you able to include any lease contracts like that?

X: To be honest I don't know because at the moment I'm selling it I guess not but I'm not sure because the part of my team who were very linear and old-fashioned didn't believe anything. Until they saw because then it gets very complicated, if you have a lease contract it's not a financial lease but you can take your budget your building budget and then it's going to be a financial trick again. They do the plants and stuff like that you don't buy plants which really makes sense because I want have plans and I don't give a s*** how you do it usually in office buildings if you buy a plant like that after a month old dead bececuse no one is watering it.

K: But that service exists already so that something easy to implement?

X: The carpet is there, and I wanted to do it for a very long time I think it's hardly I'm not sure like in the Philips parking garage they do it is very easy Schiphol they do it. Only I wanted to have the light then you have to buy everything at Phillips and that gets complicated, but you know that was 8 years ago and I think, I'm convinced it should be possible now. And it makes a lot of sense and you get a total different budget there as well.. And long-term relationships is the most important.

P: The difference between opco and propco. Is different.

X: The problem is if you have a linear process with me and you sell me this glass you want to make me excited for one moment. And then you think that was Xander I have to give in a call in 5 years because he probably needs another glass. if I say I want to have the service as a glass and I'm going to pay for 25 years just as a management company then you're and my incentive at the same that it stays as long whether to as a building or a glass of whatever.

P: How many questions do you have?

K: Just a few more maybe we can go quicker.

X: I'm not going to say anything anymore, I say yes or no.

K: You talk a little bit about who is involved, can you say anything about how you interacted with the different stakeholders? Did they meet together in meetings?

P: We had thousands of meetings

K: Did you meet together as a group and work and things at one time or did you mean individually?

X: Yeah we did, not with the owners but we did have the same time the contractor, the architect the engineer, you (Phillip) and me at the table. You are talking about a different process.

P: No.

K: I think maybe from what you have said so far, the best way to find solutions for this project is to work together toward a shared goal.

P: Of course, but the way you organize that is the way you make custom suits. So of course, we had a basic structure but then was in the structure we had some different meetings about different subjects. But the basic is we had a design team with all the designers and when there was a new idea for instance the greenhouse we looked at who should be involved in helping this concept further, so we know what we should make.

X; It was a fluent process sometimes you say I don't even know about it like a greenhouse who is going to do it? in the end the architect will see triangles on top it is a totally new thing.

P: With the innovation of this Facade we selected a facade contractor first and then the main contractor and the main contractor was part of the design team also, later on so before construction. And the facade contractor became a subcontractor of the main contractor. So that's how we did it.

X: The pointer is how do you get everyone responsible for the design?

K: Was everyone very open about sharing information?

P: It was not a big deal.

X: I think it was not a big deal. Don't underestimate it because I was the crazy guy in the process and the contractors came from the Stone Age and they didn't deny it they made a very large jump in sustainability and how this process works. You know I drove a lot of people crazy, but a lot of people said if you don't have a guy that drives you crazy it's not going to work. Even the guys from the construction team. How do you balance it?

P: And how did they put you back in your box?

X: Yeah but that's very difficult because it's also the same you can't be anything else. Let's get the thing done and now it's nice. Of course, you get this balance.

P: Can you organize innovation that is the question and how do you do that?

X: There are a lot of rules for that and we didn't know the rules by then.

P: It's a bit of a contradiction, organizing innovation.

X: It's a contradiction because the definition of innovation is that it has not been proven and everybody every stakeholder has to have risk management the project manager or contractor because in the end if you find that that's the Holy Grail of innovation especially larger developments.

P: The answer to the question before was you can create space for innovation, but you should make appointments on that at the beginning more explicit to avoid that people are saying no, you should lower your ceilings because then we can make more hotel rooms. So then your physical space would you need for innovation is gone.

X; I find that a beautiful metaphor

P: It's true it's physical space for animation it's not only organizational or mentally space but physical space.

X: What I said what makes us building sustainable and added value for property people the added value the sustainability of this building is a building with a public function in a dense built area and now I know that it's very likely that it's going to be a hotel for the first 15 years but I can also predict that the very likely if I look at the development and aging that it's going to be a senior flat in 20 years. so taking that into account make this building as flexible as possible so make the rooms this big and we throw away the 5-star brand standards because they say you have to be 30 meters now we do 25 and we make it sustainable which is the fact that every floor is totally flexible besides the hallway so if my operation in 20 years says or 10 years says we need double rooms and a kitchen because of the different functions and installations are vertical so theoretically possible and since it's been done sustainable we can remove sustainably which is very cheap. So that's one of the things which came from the vision of flexibility and my crazy thought of a living building only then you have to tell owners of property that is one of the very

big added values, that you don't have to break it down. And if you would be exactly on the brand standards and you have to convert it you have to break down the building. So you have to translate the value of your vision into commercial value And they said that's cool, so if it's not going to be a hotel this is a public function so the value over 50 years will be way more.

K: And all of these things difficult to explain to you subcontracted into this project? Was this concept of being stainable and flexible difficult to share with them?

P: It was difficult to understand what it mean, what the consequences where, nobody knew.

K: But they were willing to sign on?

P: Yeah.

K: Where did the idea to be circular come from?

X: To be honest when we started circular didn't exist and I've been in many workshops and discussions with commissioners of sustainability you know LEED, BREEAM, and WELL. And the vision of a living building or biomimicry of whatever you want to call it was there from the beginning but what does it mean will then you get a whole different discussion. Once you divide it new give it a name in your going to certify it it's not innovative anymore because you put it in rules and regulations and stuff. That's what we said we don't have a certification we just want to have a vision and the vision was a crazy guy like me just asking people what makes sense and then you get into biomimicry and now we call it circular or cradle to cradle or whatever.

K: So That was your vision but was it a difficult to get the contractor to wrap his head around that?

X: Yes and no. No because I had to tender them in a crisis. Everybody would say yeah, we will do it and we can do it. But how are you going to do and how are you going to implement an innovative team to start thinking of things we don't know exactly? That's basically, in my perception how we came to this contractor.

K: Who was the contractor?

P: JP van Aestrom, TBI. One of the 3 or 4 biggest contractors in the Netherlands.

K: So, they claimed they could do it?

P: They had done a project that was certified on Schiphol.

K: I want to ask specifically about the strategies you implemented including materials, energy, water, and waste. I've read about the recycled concrete, and the carpet that can be reused that came from fishing nets.

X: The living building was a starting point and the basic certification was LEED. And LEED says use recycled content and the materials can't be from further than you can look it up, 400 miles from the building site. if you look at every certification it comes down to the standard how do you do it? I always make a joke, I said if we would have started with LEED Platinum or LEED, point one of LEED is you have to

build 10 m above sea level because it's an American thing so it's difficult here in the Netherlands, then I have to build of poles 20 m because you're under the sea level. Go from your own strength and then look at the certifications which would make sense.

P: But the strategy for closing the circles? How do you measure your success or how do you verify if you're having the right products is basically mainly done by the certification system.

K: do you mean LEED?

P: Yes.

K: But you did many things that go beyond the certification?

X: Well we got 0 points for the greenhouse I would have gotten 20 points If I put some green plants on the rooftop but if you ask why you would do that it's for a water regulation and it's better to do that but don't stone the public space instead of these thousand square meters of roof top doesn't make sense. and I talked a lot about this with commissioners and a guy I really like he did it for the ABN AMRO and he's a commissioner of LEED, WELL and BREEAM and he said in the end if you have a good commissioner LEED is the best one he didn't like certifications either, but he said in lead the L for LEED is LEADING so the certification in his perception as an expert is the most flexible because you can challenge you can add points he said I don't agree with this point because and you should have a very proactive ambassador in your commissioner. It all comes down at ambassador and all the different stakeholders.

P: But you have two kinds of certification, your certification for your building or construction. And you have the certification of your process your operations. So where we were involved was for the certification of the construction building. And then I don't know if the operations have a certification and Green Key or LEED.

X: The funny thing was we challenged IHC to have a very sustainable building.

P: They have green engage.

X: And I said to them ok we're going to do circular and this and that and save so much water and they say it's not possible but the company that was involved in our development was ARUP and I knew ARUP did the whole sustainability vision LEED vision for IHC so I said if you don't believe me I have ARUP to talk to. So, they asked ARUP to have their sustainable it's called Green Key or green management or whatever and there we got into a conflict because I was putting level too high and they said cant you do LEED silver I said what the f*** do you mean because it was scary for them because I would be the only LEED Platinum.

P: We tried to incorporate the green management ideas. The whole procurement of goods, foods, laundry etc. should be sustainable but I don't know how it turned out.

X: I do. From the sheets to the mattresses to the boxes that creates to the Dutch drinks you basically you don't have foreign drinks but it's a vision because you can't put it in the certification or in a rule you have to make people from the bar keeper to the coffee grinder.

P: You have to educate your people that's a very important thing to do.

X: In the end it's the most important.

P: So, you have to tell the story which they match must tell to the customers.

X: I have to let go somewhere that is very difficult for me but then you see if you look for coffee you have a lot of opportunities and you also have to choose the most sustainable. I have a very funny or nice example if you have a product as a service and the producer stays responsible for it also for the waist line he's going to think what can I do with the waste and one of the examples we still have to implement are going to implement is I don't buy the coffee you make it and I say you have to be nice for staff and the forest and I rent it from you to make coffee and then you get it back. and then you say s*** I have all of this coming back what can I do with it and it was one of the best fertilizers for mushrooms. So the waste cycle I want to make clear here to give some examples that's the same with the greenhouse that we have aquaponics in fish poop fertilizer you can give examples of small closed waste cycles which you can use as a blueprint to upscale it the sewer greywater whatever. Whatever waste cycle you need then you'll have to educate everybody because it's sometimes structural or financial.

P: But we wanted to stay away from was all the plaques everywhere from don't do this don't do that we change your laundry only once a week. It must be luxury. Shall we go upstairs?

C. Reflection

K: Last question, what would you say reflecting on the project was successful or lessons learned overall?

X: I would say for me it was very tough you have to be a little bit crazy to keep going on. I'm convinced with all of the problems that emerged I'm going to take this experience and move it to all the world very practical and go to an island like that. So, in that sense it's been a success and it's been very difficult it's not been always funny but, in the end, if you ask me now and we can tell days about problems and crazy people and horrible people and yes it was a success. It's scalable and people are coming to me and I'm very surprised because I still have the idea like I don't know anything, and I don’t.

Appendix 7: TSH Delft goes circular

THE STUDENT HOTEL

TSH Delft goes circular!

To be able to reach the company goal of having a circular fit out for the TSH Delft ground floor, a definition needs to be formulated. This definition forms the basic framework to which all decisions concerning implementing items following the Circular Economy (CE) principle can be measured. As the general definition of CE within the building sector is still not widely adopted, we have the flexibility to add and take from it whatever we want.

When researching different working definitions of CE, we found the following sentences, key words and principles:

Aim:

The aim should be to create a system that allows for the long life, optimal reuse, refurbishment, remanufacturing and recycling of products and materials.
From <https://kenniskaarten.hetgroenebrein.nl/en/knowledge-map-circular-economy/what-is-the-definition-a-circular-economy/>

Key Words:

a. *Durable / Longevity / Long-life*
b. *Maintaining value*
c. *Optimal reuse*
d. *Refurbishment*
e. *Remanufacturing*
f. *Recycling of materials*

Design Principles:

a. *Design for longevity (long-life);*
b. *Design for leasing/service;*
c. *Design for re-use in manufacture; and*
d. *Design for material recovery.*

With the understanding of the principles of CE, the TSH flavour can be added, leading to the TSH CE working definition:

"Circularity for TSH Delft represents a hotel that is designed for longevity, re-use and recovery of materials and products, and where these elements are added to the definition of value, without losing the TSH Brand Identity of well-designed spaces and optimal guest experience. "

To explain this a bit further:

"a hotel that is designed for longevity, re-use and recovery of materials and products"

This passage reverts to the design principles of CE that can be controlled by TSH or her designers. Every design decision can be held to these principles, in which the most desired outcome is that the product fits in all categories. Meaning that it is very durable, can be re-used and all materials can be recovered fully. Reality check; probably this will not be the case. So, we aim to have all our products committing to at least one of these design principles and make it quantifiable.

THE STUDENT HOTEL

Design principle	Indicator
Longevity	Desired Life span in years Usable life span in years Ease of maintanance / repair ...?
Re-use	After life purpose Standardisation ...?
Recovery	Dissassemblability (%) Modularity ...?

"*where these elements are added to the definition of value*"

Designers and engineers can really make a change here, their creativity can lead to a smart approach to raw materials as well as to upgrade waste to something cool. If we create products that are more durable and are designed with the future life of the product in mind, it might mean that we do not have to invest in new stuff as often as we now do. Or that we can disassemble a product to serve a different purpose in the future. Or maybe we invest now in mattresses that are more expensive but can be traded for new mattresses after the first life cycle. This might mean that we must invest more up front but are assured of a lifelong of new mattresses and avoid massive refurbishments in the future. Together we can redefine the perception of value, so we also need financial and legal "engineers" to re-think the way we approach value and purchasing. The goal should be to get rid of wasteful one time use because it's the most financially attractive thing to do NOW. We're in it for the long run, hence all different departments should be at the table to achieve this new definition of value.

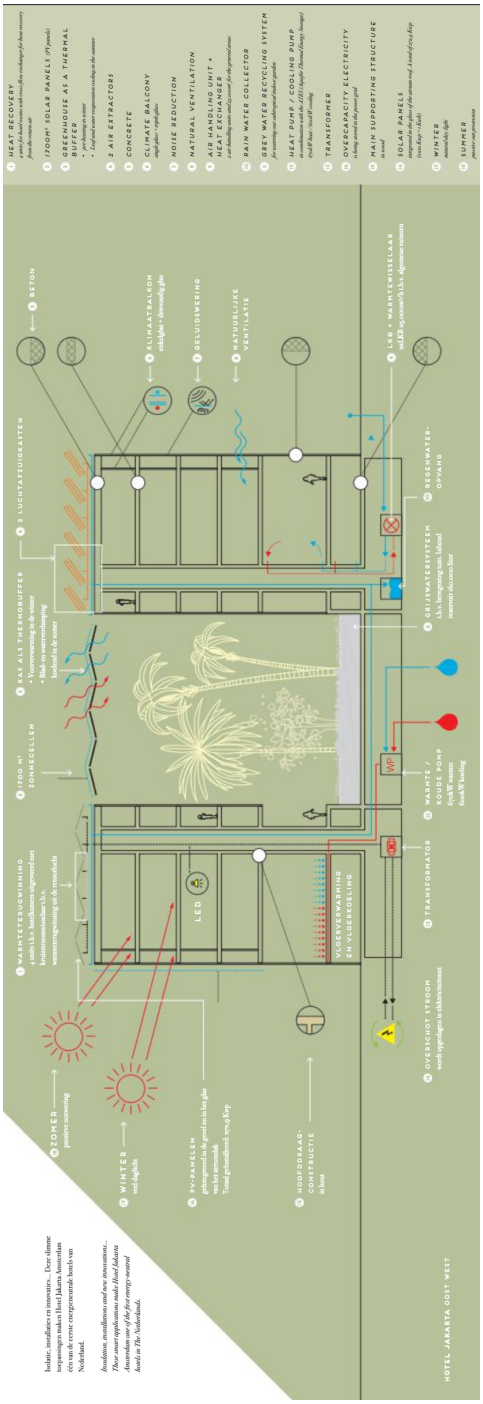
Value
Total Cost of Ownership
End of life value
Products as a service
De-risking operation though long-time partnerships

"*without losing the TSH Brand Identity of well-designed spaces and optimal guest experience*"

We will expect the TSH Designers to embrace circularity without losing our brand identity in the broadest sense. We don't feel like a circular built and run hotel, should have its own look and feel. Maintaining our identity also calls on our core value to change the world for the better and be best in class. This goes for the design of the space, as well as the use of space and products used and sold in the hotel. Our ambition should be that guests know that they're in a circular hotel, without actually seeing it.

TSH Brand
Optimal guest experience
Well designed spaces
Deliver a positive impact on the world

Appendix 8: Hotel Jakarta energy scheme



Appendix 9: TSH Flooring options

Flooring LCA - total m2 = 1.367m2	Decision	Cost	CO2 emitted during all life cycle stages (tons, calculated from One Click LCA)	Look	Installation	Material production	Production location	Operational considerations	Life span	End of life	Circularity notes (certifications?)	Notes
Bolidt - 700	Non-circular alternative to current product	€45/sqm installed price in the NL		available in many colors, and terrazzo look	more resilient	epoxy based, motor with natural aggregates, no harmful vapors, low VOCs	produced in Netherlands, most raw materials from Germany and Europe, some from abroad		10 years maintenance free - 25 years no production issue	can coat over it, with Boldt 550, or 700 if able to loose , concrete torn out and reused as recycled concrete, used as an aggregate		
Bolidt - 550	Non-circular alternative to current product	€35/sqm installed price in the NL		available in many colors, and terrazzo look	5mm in total- 3mm of leveling screed and 2mm self leveling epoxy, matt in traffic areas	85% natural raw materials, self leveling epoxy base,	produced in Netherlands, most raw materials from Germany and Europe, some from abroad		10 years maintenance free - 25 years no production issue			
Bolidt 525	Current product	€40-45/sqm installed price in the NL		can be deco - base color with flakes		4 layer system on polyurethanes, less prone to scratching, can add 5th clear coat as protection, 85% responsibly harvested materials	produced in Netherlands, most raw materials from Germany and Europe, some from abroad		10-15 years - renovation is sanding and sipply new top coat, can change color if wanted	if on screed can be taken out- or used as a base for new flooring or new Boldt system		
Senso unicolor	Circular alternative to current product	€ 70/sqm - color change € 35/sqm, installed, now € 55/sqm		seamless resin flooring - all RAL NCS or Sikkens colors possible, only some colors have C2C certification	local installation teams in: ENGLAND THE NETHERLANDS GERMANY SWISS	65% plant oil from castor bean, 25% natural quartz from Germany, 5% additives for material flow/ de-airing and to achieve high mechanical properties, 15% isocyanates to cure and reach tensile strength. durability and overall performance	Netherlands	vacuum, water and mop, chemicals discouraged	Senso can take it out at the end of life and reuse it to make new flooring, or leave it as a base for new flooring	Senso can take it out at the end of life and reuse it to make new flooring, or leave it as a base for new flooring	cradle to cradle silver for some colors.	Senso has an ISO 1400:2015 certification, product has AgBB certificate (VOC free)
Senso aggregate	out of budget	€120/sqm, installed		seamless resin flooring - all RAL, NCS or Sikkens colors possible, only some colors have C2C certification	local installation teams in: ENGLAND THE NETHERLANDS GERMANY SWISS	65% plant oil from castor bean, 25% natural quartz from Germany, 5% additives for material flow/ de-airing and to achieve high mechanical properties, 15% isocyanates to cure and reach tensile strength. durability and overall performance	Netherlands	vacuum, water and mop, chemicals discouraged	indefinite - can be reseald for € 20/sqm if necessary	Senso can take it out at the end of life and reuse it to make new flooring, or leave it as a base for new flooring	cradle to cradle silver for some colors	Senso has an ISO 1400:2015 certification, product has AgBB certificate (VOC free)
Tarkett - iQ one - homogeneous	cradle to cradle certified vinyl alternative to current product	€50/sqm product price, excluding installation and polish price	20 T	speckled look	fixed with glue, scraps taken back and recycled into same product, ways to install without glue so that it could be taken out easily, or sub floor can be reisled with foil on top and taken out easily			clean with neutral cleaning material, scratches can be polished away, after installation an operation tutorial is given, basic chemical cleaning needed	15-20 years	buy back option - charge for it - price unknown - fully recyclable	cradle to cradle gold certification	>5000m2 custom colors can be done
Tarkett - ID revolution	does not meet aesthetic demands	€40/sqm product price, excluding installation		wood or stone look	fixed with glue or double sided tape, scraps taken back and recycled into same product			tiles so can be replaced individually, basic chemical cleaning needed	10-15 years	buy back option - charge for it - price unknown, fully recyclable - ways to install without glue so that it could be taken out easily	cradle to cradle gold certification	>1,500m2 custom colors can be done
**Tarkett - linoleum - **	Linoleum not a feasable product because of maintenance	€30/sqm product price, excluding installation						must be treated with polymer every 3 years and whole room must be cleared out for this, basic chemical cleaning needed		not recyclable	cradle to cradle gold certification	
Forbo - Marmoleum 2.5mm Sheet	not cradle to cradle certified	€40.75/sqm product price, excluding installation	2 T	range of colors, can have marbled look	cutoffs collected and recycled into new Forbo flooring in Scotland	97% natural raw materials, 72% of which are renewable (grow back <10 years), 45% partially recycled content	Assendelft, Netherlands Kirkcaldy, United Kingdom	designed for easy maintenance	25+ years	burn it, not yet able to be recycled at end of life		currently developing a buy back option?
Forbo - vinyl Allura color	not cradle to cradle certified	€58.10/sqm product price, excluding installation	12 T	range of colors with speckled look	collect cutoffs - not clear if they care recycled	backing may be 70% recycled content	Europe		15 years			
Nora - norament flooring	rubber flooring does not meet aesthetic demands	installed: 70-90 e/m2 ex taxes and ex leveling compound	42T	rubber flooring: range of colors, speckled look available		natural and industrial rubber, raw mineral materials, production scraps recycled		no coating, low maintenance requirements, can be cleared with only water	30 years	no buy back program yet	Cradle to cradle silver, company is carbon neutral and owned by Interface, EPD	Galerien Tantaflow building in limburg
Nora - Norsplan	rubber flooring does not meet aesthetic demands	installed: 70-90 e/m2 ex taxes and ex leveling compound	23 T	rubber flooring: range of colors, speckled look available		natural and industrial rubber, raw mineral materials, production scraps recycled					working on cradle to cradle certification maybe gold , company is carbon neutral	

Appendix 10: TSH Delft EPC calculation

Uniec 2.2 STUDIEBEREKENING

- 20162134 - The Student Hotel Delft - Current
Definitief 1,00

Jaarlijkse hoeveelheid primaire energie voor de energiefunctie		
verwarming (excl. hulpenergie)	$E_{H;P}$	771.226 MJ
hulpenergie		364.695 MJ
warmtapwater (excl. hulpenergie)	$E_{W;P}$	697.447 MJ
hulpenergie		8.073 MJ
koeling (excl. hulpenergie)	$E_{C;P}$	118.[illegible] MJ
hulpenergie		[illegible]
zomercomfort	$E_{SC;P}$	[illegible] MJ
bevochtiging	$E_{hum;P}$	0 MJ
ventilatoren	$E_{V;P}$	524.[illegible] MJ
verlichting	$E_{L;P}$	1.197.469 MJ
geëxporteerde elektriciteit	$E_{P;exp;el}$	0 MJ
op eigen perceel opgewekte & verbruikte elektriciteit	$E_{P;pr;us;el}$	626.870 MJ
in het gebied opgewekte elektriciteit	$E_{P;pr;de}$ [illegible]	0 MJ

Oppervlakten		
totale gebruiksoppervlakte	$A_{g;t;}$ [illegible]	10.581,98 m²
totale verliesoppervlakte	[illegible]	10.115,50 m²

Elektriciteitsgebruik	
gebouwgebonden installaties	399.606 kWh
niet-gebouwgebonden apparatuur (stelpost)	334.709 kWh
op eigen perceel opgewekte & verbruikte elektricite[illegible]	68.020 kWh
geëxporteerde electriciteit	0 kWh
TOTAAL	666.296 kWh

CO_2-emissie		
CO_2-emissie	m_{co2}	187.293 kg

Energieprestatie		
specifieke energieprestati[illegible]	EP	289 MJ/m²
karakteristiek ener[illegible]ik	E_{Ptot}	3.055.901 MJ
toelaatbaar karakte[illegible]iek e[illegible]ergiegebruik	$E_{P;adm;tot;nb}$	3.056.952 MJ
E_{ptot} / $E_{P;adm;tot;nb}$ (Bouwbesluit)		1,00 -
E_{ptot} / $E_{P;adm;tot;nb}$ (energielabel)		0,56 -
energielabel nieuwbouw utiliteit		A+++

Alle bovenstaande energiegebruiken zijn genormeerde energiegebruiken gebaseerd op een standaard klimaatjaar en een standaard gebruikersgedrag. Het werkelijke energiegebruik zal afwijken van het genormeerde energiegebruik. Aan de berekende energiegebruiken kunnen geen rechten ontleend worden.

Uniec 2.2 STUDIEBEREKENING

- 20162134 - The Student Hotel Delft
Definitief **0,81**

Jaarlijkse hoeveelheid primaire energie voor de energiefunctie		
verwarming (excl. hulpenergie)	$E_{H;P}$	425.897 MJ
hulpenergie		364.695 MJ
warmtapwater (excl. hulpenergie)	$E_{W;P}$	610.76[illegible] MJ
hulpenergie		8.073 M[illegible]
koeling (excl. hulpenergie)	$E_{C;P}$	114.[illegible] MJ
hulpenergie		[illegible]
zomercomfort	$E_{SC;P}$	[illegible] MJ
bevochtiging	$E_{hum;P}$	0 M[illegible]
ventilatoren	$E_{V;P}$	524.[illegible] MJ
verlichting	$E_{L;P}$	1.169.711 MJ
geëxporteerde elektriciteit	$E_{P;exp;el}$	0 MJ
op eigen perceel opgewekte & verbruikte elektriciteit	$E_{P;pr;us;el}$	748.501 MJ
in het gebied opgewekte elektriciteit	$E_{P;pr;de[illegible]}$	0 MJ

Oppervlakten		
totale gebruiksoppervlakte	$A_{g;t;[illegible]}$	10.581,98 m²
totale verliesoppervlakte	$A_{[illegible]}$	10.115,50 m²

Elektriciteitsgebruik	
gebouwgebonden installaties	349.236 kWh
niet-gebouwgebonden apparatuur (stelpost)	334.709 kWh
op eigen perceel opgewekte & verbruikte elektricite[illegible]	81.218 kWh
geëxporteerde electriciteit	0 kWh
TOTAAL	602.728 kWh

CO_2-emissie		
CO_2-emissie	m_{co2}	151.388 kg

Energieprestatie		
specifieke energieprestati[illegible]	EP	233 MJ/m²
karakteristiek ener[illegible]iegebruik	E_{Ptot}	2.470.062 MJ
toelaatbaar karakte[illegible]iek energiegebruik	$E_{P;adm;tot;nb}$	3.056.952 MJ
E_{ptot} / $E_{P;adm;tot;nb}$ (Bouwbesluit)		0,81 -
E_{ptot} / $E_{P;adm;tot;nb}$ (energielabel)		0,46 -
energielabel nieuwbouw utiliteit		A+++

Alle bovenstaande energiegebruiken zijn genormeerde energiegebruiken gebaseerd op een standaard klimaatjaar en een standaard gebruikersgedrag. Het werkelijke energiegebruik zal afwijken van het genormeerde energiegebruik. Aan de berekende energiegebruiken kunnen geen rechten ontleend worden.

Appendix 11: TSH Development cycle