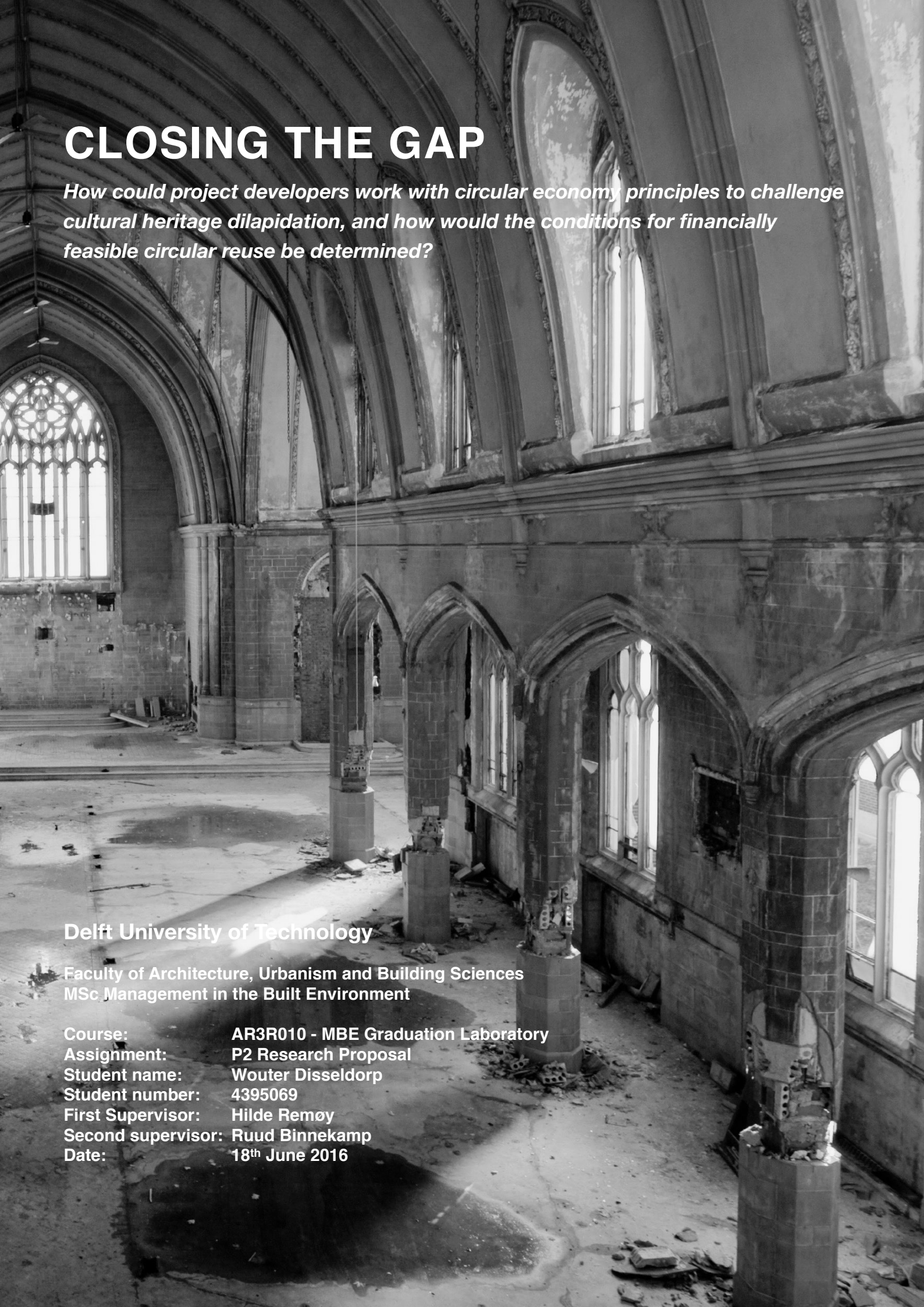

CLOSING THE GAP

How could project developers work with circular economy principles to challenge cultural heritage dilapidation, and how would the conditions for financially feasible circular reuse be determined?

Delft University of Technology

Faculty of Architecture, Urbanism and Building Sciences
MSc Management in the Built Environment

Course:	**AR3R010 - MBE Graduation Laboratory**
Assignment:	**P2 Research Proposal**
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Foreword

With this research it is my intention to find a solution for the vacancy and dilapidation issues heritage currently faces, by developing a financial framework related to ‘circular economy’ principles of the built environment.

This report includes my proposal, developing a research design as a second step of the 5 phases of graduation. Within this perspective the problem statement will be clarified, relevant research questions will be presented and the target group will be identified. Subsequently the intended research methods for the main research question will be explained. Lastly the predicted results will be given. But first, my personal motivation is presented below.

Abstract

Table of content

Terminology

Part I: An introduction to new investments for adaptive reuse of heritage

1. Introduction

The first section illustrates the initiative and further background information of this thesis. First, the motivation for this subject will be elaborated, followed with the research objective and problem analysis. Conclusively the problem statement is identified, to conclude with the research questions and the scientific and practical relevance.

1.1 PERSONAL MOTIVATION

My initial goal was to start studying to become an architect. The creativity and insight on new potential with designing intrigued me. During my study to acquaint the competence of an engineer with enthusiasm and full effort, my perspective on the built environment broadened further towards societal, cultural and economic perspective. From this perspective, the main objective within the profession of project development is creating added value, on both financial, ecological and social aspects, for the entire lifecycle of buildings. Architecture became a tool to achieve the overall purpose.

Ever since graduating for the BSc of applied science, which focussed on a more technical perspective of the built environment, my interest was to contribute to a more sustainable solution throughout the real estate lifecycle. Despite the technical potential to enhance the real estate stock, until now the managerial and financial aspects lack to perform on an more equivalent principle. It is my intention to provide a solution to create a viable option for reuse of heritage.

My fascination for the circular economy lies within the believe for a disruptive approach in the built environment. The opportunity to provide a solution for the current lack on waste management and linear consumption is evident. An opportunity to acquaint knowledge about implementation of circular redevelopment, and contribute to accelerate a world driven by the circular economy.

1.1.1 Study Targets

In order to acquaint the most knowledge and to make best use of the graduation process, following study targets will be set and should be achieved at the completion of this thesis. The targets are divided in general and personal goals. Within this, the general study targets for this research project are:

- Contributing to the current academic body of knowledge on this subject
- Understanding different research methods and techniques
- Finding out the applicability of theory in practice
- Discover the gap between theory and practice
- Closing this gap between theory and practice

Personal study targets for this research project are:

- Get acquainted in writing an academic thesis
- Learning more about sustainable redevelopment of real estate
- Providing a solution to improve the existing stock by viable redevelopment strategies
- Learning more about strategic, political, social and economic aspects in redevelopment projects

2. Background

2.1 PROBLEM DEFINITION

The current environmental situation as a result of human life reflects the demand for more consciousness on the embedded energy of buildings. Moreover, due to the economic crisis the perceived naturalness to demolish existing buildings for new development is outdated.

Research have shown that around half of all non-renewable resources mankind consumes are used in construction, making it one of the least sustainable industries in the world. In Europe, the built environment accounts for 40% of the energy and material consumption and waste generation, and further contributes around 35% of all CO_2 emissions (UNEP, 2009; Dixon 2010; Schoolderman, 2014).

With 80% of next century's building demand already built, it is essential to provide a sustainable solution by reusing this stock, and avoid vacancy and dilapidation. Hence, new functions should be accommodated in existing buildings, through sustainable adaptive reuse. However, traditional approaches are failing. Currently the feasibility studies for redevelopment projects do not consider the societal benefits related to heritage, which might be the solution for accelerating reuse potential. New, innovative business models are needed to enable maintenance and adaptive reuse of heritage buildings in order to fill up this 'investment gap'.

The main question from this perspective is: what are the main aspects of adaptive reuse to actually change the city's future? The knowledge regarding financing as well as business models is limited. Until date no clear and specific key indicators are identified (van Velzen, 2009). Furthermore it was not possible to determine the market value of renovated heritage (in the Hague)(Barentsen, 2015). However, in order to enable politicians and the public to recognize the scale of the opportunity, the change it might bring will have to be put in perspective of health and safety.

Especially the societal benefits of heritage in the environment could be of major importance for the city's future. An attractive environment contributes to the joyful living of residents and ensures an healthy and safe environment. Therefore this research is limited to the extent of political and public intentions in relation to the private developer.

2.2 MARKET CONTEXT

The real estate market is characterized by its static appearance, and the recent credit crisis accelerated consciousness to preserve the built environment. The ideology to improve the energy performance of heritage aims to provide a solution for global warming. Moreover new insights for financing methods of intangible assets from perspective of the society help to accelerate new initiatives in a collaborative way.

Given the previous mentioned aspects for a future sustainable environment, both the current market, sustainability interventions and valuation methods of cultural heritage will be investigated.

2.2.1 Vacancy in the Netherlands

Numerous types of cultural heritage like churches, municipal monuments schools or industrial heritage, are all illustrative examples of real estate with architectural, emotional or historical value. Due to their representative functions it is out of question to be eligible for demolishment.

The societal value captured within cultural heritage is recognized by Jacobs since 1960: “New ideas occur in old buildings.”(Jacobs, 1961). Multiple other authors validate the importance of cultural heritage (Florida, 2002; Marlet, Ponds, Poort, & Woerkens, 2015; Tallon, 2013).

Despite the emphasis on the importance of aforementioned societal value, the vacancy and dilapidation issues are remarkable. Currently this amount includes 2 million m2 of heritage buildings the Netherlands, and that the number is growing (AMS, 2016; BOEI, 2016).

Local authorities could potentially fulfill a more decisive role in the solution for aforementioned vacancy and dilapidation issues. Due to the so-called ‘participation society’, which emerged from governmental policies, local authorities and public agencies are challenged to innovate and deal with smaller budgets. Further, the decentralization of responsibilities illustrate the spectrum in which municipalities have to deal. Cultural heritage could be deployed as incubator for more economic growth. Until date, the majority of renovation- or transformation projects fail due to multiple reasons like procedures or financial constraints (BOEI, 2009). The main question to be answered, how to act on the cultural heritage which face the above mentioned vacancy and dilapidation issues?

2.2.2 Sustainability Context in the Netherlands

In the current linear economy we take, make, use, and dispose. Resources are mined without thinking about the future generations of people and animals that need to survive on this planet. Especially in the 20th century the increasing population and the simultaneous prosperity increase led to a massive growth in the mining and usage of building materials. Research shows that it has increased by a factor of 34 since the beginning of the 20th century (Bastein, Roelofs, Rietveld, & Hoogendoorn, 2013). In our current, linear economy, approximately 80 % of what we use is directly discarded after usage (Sempels & Hoffmann, 2013). Other research even concludes that over 99% of the total material flow generated in order to produce consumer goods ends up in waste disposal within 6 months (Hawken, 1999).
As of 2013 humanity used the equivalent of 1.6 Earths to provide the resources we use and absorb our waste (Global Footprint Network, 2013). A realistic prediction is that the global consumption of materials will triple by 2050 (UNEP, 2011). This way the earth cannot keep up with the rate of consumption. The result is global resource depletion.

Due to the linear thinking model the amount of waste that is produced is high. According to the European commission twenty five to thirty percent of the waste produced in the EU can be identified as construction or demolition waste. And most of the materials, and components that are recycled are actually being down-cycled. They are taken apart and lose their value.

Beerda states that the problems that are occurring in the building sector are due to the long life/use cycle of buildings, ineffective leadership, and a poor organization. People and companies are afraid to change what is, in their eyes, already working fine (Beerda, 2014).

The concept of ‘Circular Economy’ refers to a new economic and industrial system in which (raw) materials and components are kept on their highest value. Ellen Macarthur Foundation illustrates the continuous flow of technical and biological materials through the ‘value circle’. The circular economy outlines the capacity to rebuild capital, whether this is financial, manufactured, human, social or natural (Ellen MacArthur Foundation, 2015). This means that the first step is maintenance, subsequently reuse, refurbish, and recycling as shown in figure 2.1 below. In this way the dependency on depletable resources and the amount of construction and demolition waste can be minimized. To move towards a circular economy for redevelopment opportunities a lot of research still has to be done. This research focuses on the applicability of circular business concept in order to accelerate the reuse potential of desolated cultural heritage.

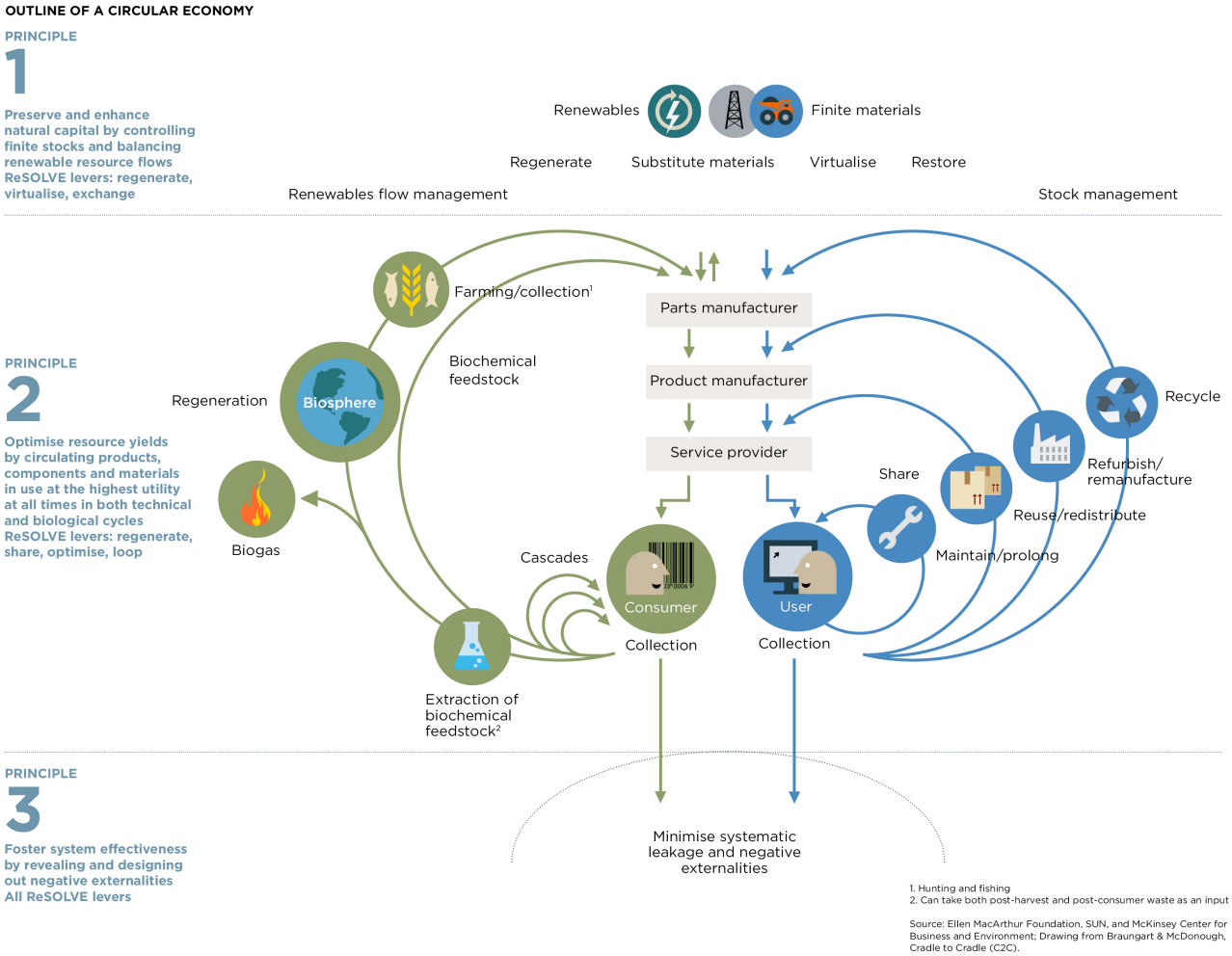

Figure 2.1: Outline of a circular economy (Ellen MacArthur Foundation, 2015).

2.2.3 Financial Context in the Netherlands

Most research is done by investigating the so-called 'willingness to pay' with regards to cultural heritage. Within this perspective the notion to contribute to preservation by investing in cultural heritage is perceived beneficial for society. However there is a much wider spectrum of cultural heritage than solely the buildings that should be preserved in their original state for future generations. According to Barentsen (2015), in the Netherlands new views on heritage preservation state that heritage should no longer be seen as isolated parts of society which should be protected from change.

'The new opinion about heritage preservation stimulates heritage to be an integrated and dynamic part of society. In this way heritage is believed to be an important catalyst for local economy. This change allows for buildings with a special cultural historic character to be re-designed or transformed after they lose function' (Barentsen, 2015).

Why do redevelopment- and renovation projects fail to be viable? The commonly known bottlenecks are complexity, uncertainty and significant risks related to redevelopment projects. These hazards are especially applicable for redevelopment projects, by changing the characteristics of an existing buildings to fit purpose for new functions. Therefore, redevelopment

projects are perceived expensive and time consuming, even compared to renovation projects. However, this does not imply that renovation is always the best alternative. The best solution is subject to the equation of acquisition and investment necessary for the new function, together with the future value of this new function. The recurring bottleneck here is the financial feasibility of redevelopment or renovation.

A project is financially not feasible when the required returns on acquisition and necessary investments for redevelopment and exploitation are not met in a reasonable time frame with revenues of future use (Schmidt, 2012).

Unfortunately the discrepancy of estimated value between property owners and redevelopers currently withholds the reuse potential of cultural heritage. From perspective of a property owner the estimated market value is usually based on the income approach, i.e. the generated income when fully functional. Contrary, the redevelopers calculate the potential of a property based on residual land value. As long as these two methods of calculating are not equivalent, the investment gap between perceived minimum price level for the property owner and maximum investment by redevelopers could hardly be closed.

2.2.4 Towards Circular Cultural Heritage

The first and underlying objective of this research is to provide a solution for the vacant cultural heritage. With a new a business concept based on the circular economy, a network of local economies could function more efficiently and result into a beneficial alternative for redevelopment.

Preferably a building is reused as a whole. Currently, when a building doesn't meet the standards anymore the first option considered is demolition. To preserve the embedded energy of the building components and materials a renovation or redesign would be a more sustainable choice.

The concept of 'Circular Economy' refers to a new economic and industrial system in which (raw) materials and components are reused, refurbished, and recycled instead of discarded. It is important to maintain the highest material value possible. The circular economy is not only about money and material flows. It is also about creating a different vision, a sustainable ideology for society. This is called circular thinking.

2.2.5 Project & Design

Second objective is to clarify circularity in redevelopment projects from perspective of both organization and financial feasibility. The most important part of this aspect is doing research into setting up a framework for the developer. The framework needs to guide towards circular development with the emphasis on the use of a integrated network of multiple businesses. With the integration of waste of old production process into capital for new products a building can be the link between the two production lines.

To set up a framework for the reuse of cultural heritage and the use of circular economies as an aid, some criteria in terms of circular thinking have to be established. The same has to be done for the redevelopment process more specifically. These criteria will be given in the chapter results.

Part II: Research approach for new investment potential

3. Research Objectives

3.1 PROBLEM STATEMENT

The previous introduction to the context enumerates the current situation of cultural heritage regarding the behavior on the real estate redevelopment market, sustainability interventions and valuation methods in the Netherlands. Important is the emergence of the consciousness to improve energy performance and financing structures to accelerate new initiatives in the future. Altogether, this leads to the following problem statement.

The current vacancy and dilapidation issues of heritage is widely recognized. The Netherlands cope with vacant cultural heritage, and simultaneously the quest for a more sustainable world has never been more urgent. Within this perspective the preservation of cultural heritage results with numerous societal benefits. The belief to actively integrate cultural heritage into the dynamics of society, and contribute to the economy would help to perserve heritage in a sustainable way.

Currently the Dutch real estate market is reluctant to participate into new investment alternatives for redeveloping real estate. Solutions to prevent vacancy and dilapidation like renovation and conversion regularly fail due to numerous reasons, for example due to the complex and inefficient redevelopment process and financial constraints. It is helpful to investigate the potential of local economy to invest in redevelopment of heritage. The phenomenon ‘circular economy’ could contribute and accelerate adaptive reuse of cultural heritage.

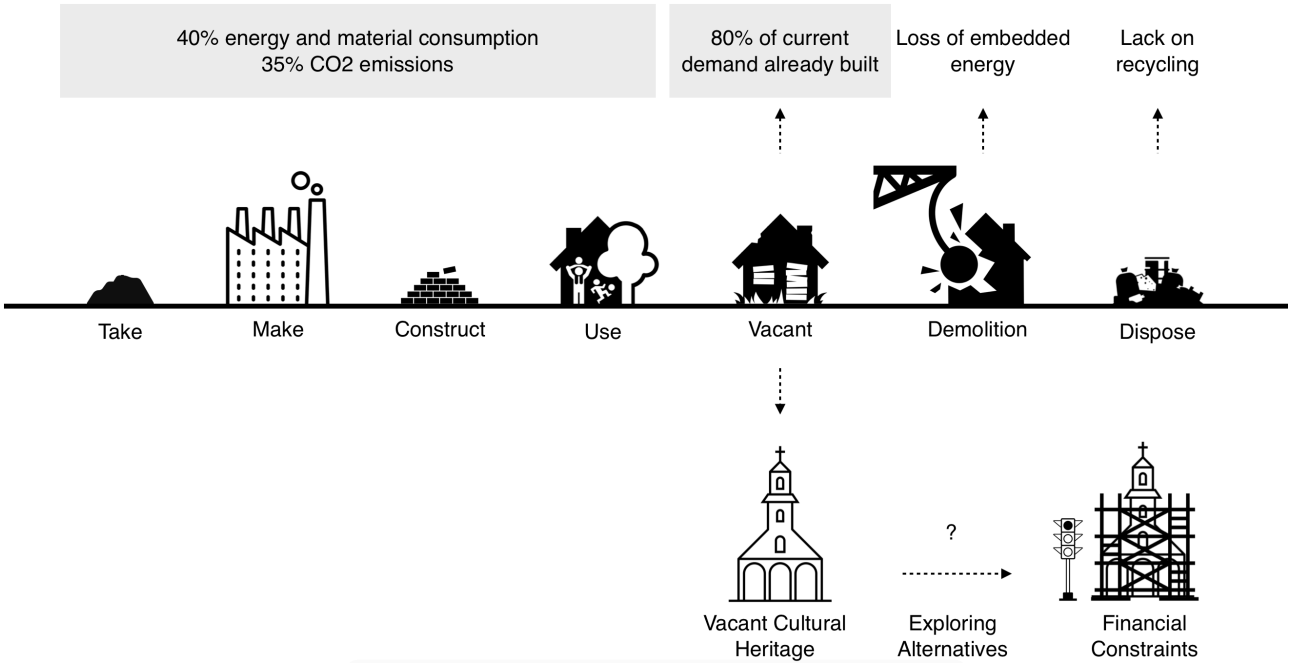

Figure 3.1: Visual explanation of problem statement (own illustration)

3.2 RESEARCH QUESTIONS

3.2.1 Main question

The presented problem statement results in the following main question:

How could project developers work with circular economy principles to challenge cultural heritage dilapidation, and how would the conditions for financially feasible circular reuse be determined?

3.2.1 Subquestions

In order to be able to understand this question, first, the terms ‘circular economy’ and ‘investment gap’ will be explained. Furthermore the motivation for heritage renovation projects should be clarified. Subsequently, insight on the current situation will be given, and ultimately the potential future situation can be identified according to the presented conditions for feasible renovation according to the circular economy principles in both a financial- and business model. The subquestions are divided over both the current situation and future opportunities for renovation projects.

3.2.2 Current situation

Vacant Cultural Heritage
- *What are the main organizational impacts/constraints for reuse projects?*

Circular Economy
- *What influence could the circular economy have on the financial constraints related to cultural heritage redevelopment projects?*

3.2.3 Future circular redevelopment opportunities

The alternative future situation will be set-up and tested, based on two main aspects: organization, and financial feasibility. The third aspect is explorative, and supports the applicability of the two main objectives with recommendations for strategic implementation: policy.

Organization
- *How is an organization for a circular redevelopment project structured?*
- *What type of circular business networks should be considered viable for redevelopment purpose?*

Financial feasibility
- *What is the cost- benefit analysis for circular redevelopment project, from perspective of the developer?*
- *What are the subsidies and financing opportunities currently provided for circular/heritage reuse projects?*
- *What financial framework would be applicable for a circular redevelopment project?*

Policy
- *How could local authorities cope with the innovative concept of a circular economy?*

3.2.5 Future vs. current redevelopment projects

In order to verify the potential of circular redevelopment, the potential future situation will be compared with the current situation. The differences will focus on both organization and financial

feasibility. The policy aspects within this research relate to recommendations for implementation and governance.

- *What are the main differences of circular redevelopment with the traditional redevelopment projects?*

3.2.4 Background questions

In order to help answer the subquestions, answering the following questions will help to define the goal of this research and provides an outline or aim during the research proces:

- *What are cultural heritage buildings?*
- *What is the importance of renovation of cultural heritage buildings?*
- *How are the current business models structured?*
- *How are the current feasibility studies structured?*
- *How does the circular economy work?*
- *How could the potential of a circular economy be predicted for the redevelopment market?*

3.3 FINAL RESULT & TARGET GROUP

Since the vacancy and dilapidation of heritage concerns the socio-economic environment, most relevant target group to consider is the public. However, in order to solve this problem this research aims on both the financial model as well as the business model and will be focused on incentives for the investor to accelerate the project.Therefore research aims to identify and evaluate the financial and societal effect of circular redevelopment projects, and further to compare this set-up with traditional redevelopment projects in order to define the future financial and societal opportunities. The effect of the resulting financial framework will be observed through a case study.

3.3.1 Deliverables

The financial framework and observations could contribute to a better understanding for project developers and governmental authorities how to optimize future renovation projects, and avoid further dilapidation and vacancy of heritage.

The evaluation and the business model potentially contribute to the societal solution of structurally vacant cultural heritage, and further to improve a sustainable built environment. One beneficial outcome apart from the financial feasibility could be the efficient use of government subsidies. Another favorable result would obviously be the environmental sustainability due to adaptive reuse of existing stock, and simultaneously to diminish disposal of waste from the built environment. A financial framework will provide a clear cost-benefit analysis for both the project developer and authorizing party for any potential reuse project. Additionally, the business model to be proposed will provide new opportunities to initiate reuse projects.

3.4 FINAL RESULTS

3.4.1 Societal Relevancy

This research aims to connect the written literature about vacancy and heritage with the challenges decision makers in practice currently face. In order to solve the challenge discussed in literature, and further the situation in practice, the proposed framework could help to diminish the risks for project developers and accelerate circular adaptive reuse. Despite numerous research papers to accelerate the reuse of cultural heritage, until date it is not possible to relate this to investment opportunities in practice. By providing a business concept based on the circular economy, the sustainable ideology will help to prevent highly appreciated property from demolition and depletion.

This change in perspective towards circularity is important to address many of today's fundamental challenges. Traditional linear consumption patterns ('take-make-dispose')(Ellen MacArthur Foundation, 2015) are coming up against constraints on the availability of resources. The challenges on the resource side are compounded by rising demand from the world's growing and increasingly affluent population. As a result, observation has shown unsustainable overuse of resources, higher price levels, and more volatility in many markets. These findings are supported with research on the so-called 'biocapacity'. Whether further economic growth and increased consumption of resources will be possible is determined by this crucial factor: the limited capacity of the global ecosystems to provide us with biotic resources (e.g. cereals, fish and timber) and to absorb the waste and emissions we generate through our resource use. This capacity is called 'biocapacity' (WWF, 2008). Calculations using 'Ecological Footprint' illustrate that the world is already using around 60% more biocapacity than the global ecosystems can provide in a sustainable manner (Global Footprint Network, 2017). The Ecological Footprint warns us that with our current level of resource consumption, we are already overusing the biological capacities of the global ecosystems. As shown in figure 3.1 below, the predictions for the 'Earth Overshoot Day' based on the current way of consumption - referred to as the day on which the global consumption is equal to 200% of the earth's bio capacity - is estimated on June 28th 2030. In other words: we are liquidating the 'natural capital' of the planet, instead of living on the sustainable interest from this capital. Therefore, the main challenge for this research is to create a sustainable business concept based on circular redevelopment, in order to contribute to a sustainable environment.

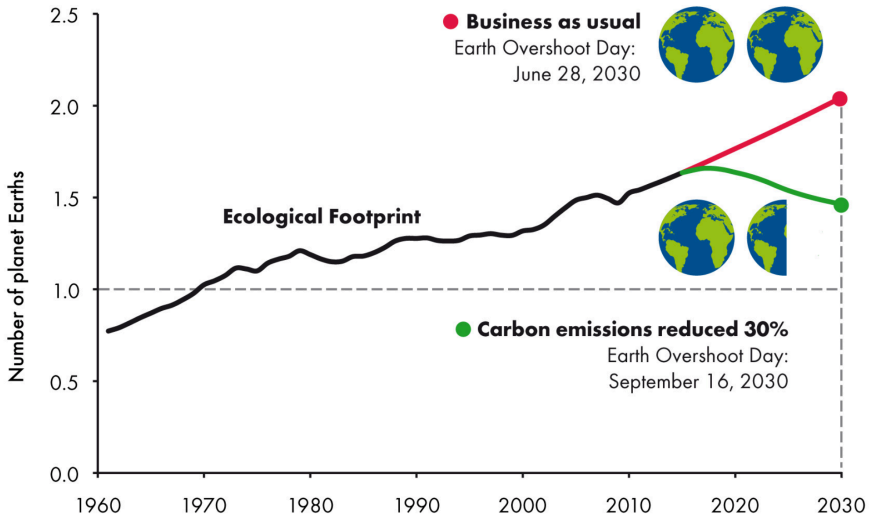

Figure 3.1: Global Ecological Footprint and forecasted Earth Overshoot Day (Global Footprint Network, 2017)

In addition to the aim for a solution to prevent climate change, the economic benefits provide an opportunity as well. While the idea of a circular economy is around for decades the current situation seems now more favorable than ever to take action. With the research 'Kansen voor de circulaire economie in Nederland' TNO stated that the circular economy potentially saves €7.3 billion and creates an opportunity for 54.000 jobs for the Dutch economy (Bastein et al., 2013). In a recent report to the World Economic Forum the Ellen MacArthur Foundation and McKinsey & Company concluded that the transition to a circular economy would create an opportunity in excess of 1 trillion USD for the global economy (Ellen Macarthur Foundation, 2014). These calculations created a huge awareness for the topic as many corporations seized their chance to get a part of this potential revenue opportunity.

3.4.2 Scientific Relevancy

Until date the available research on circular economy to contribute and possibly accelerate redevelopment of cultural heritage is limited. Moreover the knowledge to combine circular economy

principles with redevelopment projects from perspective of developers is currently lacking. However one example in practice is known - with reference to ‘BlueCity010’ in Rotterdam which was previously known as ‘Tropicana’ - unfortunately an thorough evaluation from developers perspective for further elaboration is missing. Therefore the main focus of this research is to create a guide for the developer. Based on the information extracted from the BlueCity010 case study, and further insights on the traditional redevelopment proces and circular economy principles, a new business concept will be generated.

Insight on organizational and financial aspects will help to identify main differences between the traditional and circular process. Based on the positive outcomes for circular redevelopment a new business concept provides knowledge regarding this disruptive approach on the redevelopment of the built environment. The business concept is a framework in order to guide circular thinking, circular designing and circularity in the business network of redevelopment during construction and exploitation phase of any building. There are still great opportunities in this field of research that could be investigated. This research is a small part in the broader topic of circular economy and the beginning of further research.

3.4.3 Applicability

As shown in paragraph 3.4.2, this research provides insight on organizational and financial aspects which will help to guide circular thinking, circular designing and circularity in the business network of redevelopment during construction and exploitation phase of any building. This business concept is useful for developers to determine the feasibility of redeveloping cultural heritage. The main objective - for circular economy thinking - within the profession of project development is creating added value, on both financial, ecological and social aspects, for the entire lifecycle of buildings. It is perceived that project developers provide a solution, and will stimulate and create opportunities of a circular economy with this model. This research will contribute to accelerate the transition of circular business models, which can influence all involved stakeholders within the domain of redevelopment.

4. Provisional Table Of Content P4/P5

5. Research Method

5.1 EMPIRICAL/OPERATIONAL

This thesis will be structured from both an empirical and operational perspective. Therefore several research methods will be used during the graduation process. With an exploratory approach, current strategies and determinants for redevelopment projects will be identified. Insights regarding new investment- and business opportunities in relation to organizational and financial aspects will be presented according to the acquainted knowledge. Subsequently, the possible solutions will be explained through an operational model. Finally, the potential future alternative situation will be tested through a case study. The resulting research design (Paragraph 5.5) is shown in figure 5.2 below.

5.2 LITERATURE RESEARCH

Literature research will be used in order to identify the current situation - referred to as the status quo - in which redevelopment of cultural heritage and circular economy are perceived two separated aspects within the built environment. This literature study is necessary in order to:

- Identify the current constraints and context of cultural heritage redevelopment projects
- Clarify the circular economy principles, and the beneficial aspects of such business models.
- Provide insights for an future alternative situation, on which the beneficial elements could provide a solution for the constraints of traditional cultural heritage redevelopment projects.
- Be able to compare the potential future alternative with the current situation.

During the literature research the organizational and financial aspects will be explained in order to understand the current situation. This situation reflects the issues of vacant cultural heritage and the difficulties to provide a viable solution for reuse.

5.2.1 Cultural Heritage

First the type of vacant heritage considered must be defined. Within this perspective several key aspects should be taken into account in order to define a reliable research base.

Socio-economic aspects related to cultural heritage will reflect the potential value for the environment. Either the social cohesion (value for the local residents) of the neighborhood or the economic impuls (revenues gathered from exploitation) for the municipality will be investigated.

The investment gap reflects the financial constraints in the current situation, resulting in desolated property. Within this perspective the difference between the potential value for society and risks and uncertainties for the developer to start the project will be investigated.

Directly related to the aforementioned risks and uncertainties for the developer, the determinants influencing the decision maker to reject the business opportunity are investigated.

5.2.2 Circular Economy

In addition to the cultural heritage, the principles of a circular economy are investigated. By identifying the socio-economic cost-benefits of an circular economy business concept the outlines for an alternative future situation could be determined.

Eventually the key organizational and financial indicators related to cultural heritage redevelopment projects will help to define objectives to be considered within the operational model later on.

5.3 CASE STUDY

This research will make use of a case study in which the renovation project is related to a circular business model. The project is an redevelopment project of 'Tropicana', a former tropical swimming pool alongside the Maasboulevard in Rotterdam. By interviewing involved stakeholders it is possible to find a solution for the subquestions. Most important actors involved with the project for interviewing are:

- initiator of the project, acting as project developer
- municipal authority responsible for revising the land use plan.
- local residents affected by the reuse project.

Operations research or management science is concerned with the science of decision and its application. In this domain the term *model building* refers to the process of putting together of symbols representing objects according to certain rules, to forma a structure, *the model*, which corresponds to a system under study in the real world.

The intention is to identify the costs and benefits from perspective of above mentioned actors. This will be provided through an cost-benefit analysis (CBA).

5.4 OPERATIONAL MODEL

The conclusion extracted from the empirical study will be used as input for the operational model. This operational research provides insight for a possible future solution. The process related to operational research fundamentally deviates from empirical research. The empirical research focuses on the observations from the past, and 'describes' the situation. Contrary, the operational research results from a design process and 'prescribes' the improved future situation (Barendse, P., Binnekamp, R., De Graaf, R., Van Gunsteren, L., & Van Loon, P., 2012). This operational research is however supported with conclusions of aforementioned literature study and case study.

There are multiple integrated analyzation models, such as the cost-benefit analysis, the multi-criteria analysis and the optimization analysis through lineair programming. The design of an operational model based on the circular redevelopment process is used to provide a guide for project developers. It enables to verify the consequences of a certain decision on a particular moment in time (Rotmans et al., 1996; in Brouwer & Van Ek, 2004). Within this research the most applicable method would be the optimization analysis through lineair programming. The operational model is elaborated more thoroughly in chapter 7.

5.5.2 Theoretical framework

This research focuses on two central themes, respectively the cultural heritage redevelopment projects and circular economy. These central themes represent the theoretical framework. The overarching aspect is to accelerate a transition from a linear economy towards a circular economy. The transition creates opportunities and threats to encounter.

Due to the transition, new opportunities to develop circular projects arise. Aformentioned case study 'Tropicana' is the example, in which temporary solutions are used to further exploit the concept by integrating waste as input for new business. One of the opportunities would be the limited investment capital, by reusing materials, referred to as 'urban mining'. The hypothesis of this research is to contribute to the transition towards a circular economy, by circular redevelopment of cultural heritage.

5.5.2 Project scope

Aforementioned investment gap could be diminished by implementing a circular economy based business network, which contributes to the equation and could provide a more beneficial outcome for the decision maker, in this perspective the private project developer. Therefore, not only the necessary investments rely on the beneficial outcome related to a circular business model, but more importantly, the exploitation and therefore future value should increase based on the capital value included within the materials used and circular use of resources.

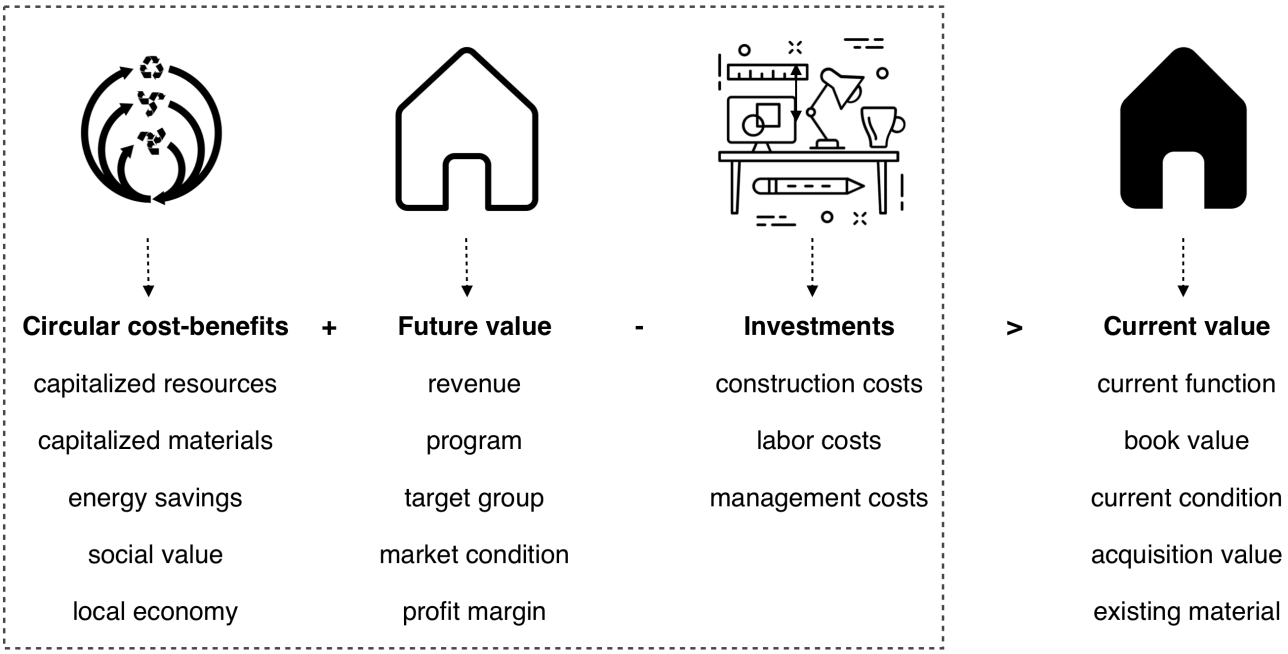

Figure 5.2: Research scope (own illustration)

Figure 5.2 shown above represents the main focus of this research, which is the redevelopment proces driven by circular economy principles. The main objective is to determine the costs and benefits of a circular network during the renovation process. Most important output however will be the performance outcome and related additional value or cost savings due to this circular business concept during exploitation. Therefore the situation prior to redevelopment and moreover the situation afterwards are essential inputs. Investment potential could only be identified through cost-benefits during the future alternative situation. Furthermore the status quo represents current disadvantages for redevelopment potential.

5.6 PLANNING

The planning is implemented within the research design (Fig. 5.3) and shows the sequence of the process globally. This Master of Science Thesis on the Faculty of Architecture Urbanism & Building Science covers two Semesters: MSc 3 & MSc 4, respectively from February 2017 until June 2017 and September 2017 until January 2018. Subject to these Semesters, five moments of evaluation provide the necessary feedback in order to guarantee the quality of this thesis. Herewith the P1 and P3 are used to check upon the progress; P2 and P4 are reference moments with a go/no-go rating; and finally the P5 is the moment of graduation, used to present the final conclusions and recommendations. The following phases are considered:

- P1: Problem statement and first literature research
- P2: Further in-depth literature research and initial hypothesis for the case study and a first concept for business model
- P3: Finalizing the case study, reflecting the results and a first input for the business model

- P4: Conclusion for the business model and reflecting with hypothesis. The final conclusion, recommendations for practice and applicability of the model.
- P5: Presentation.

5.5 RESEARCH DESIGN

The research design in figure 5.2 below represents the used research methods, and further clarifies the related planning for this gradation project in one overview.

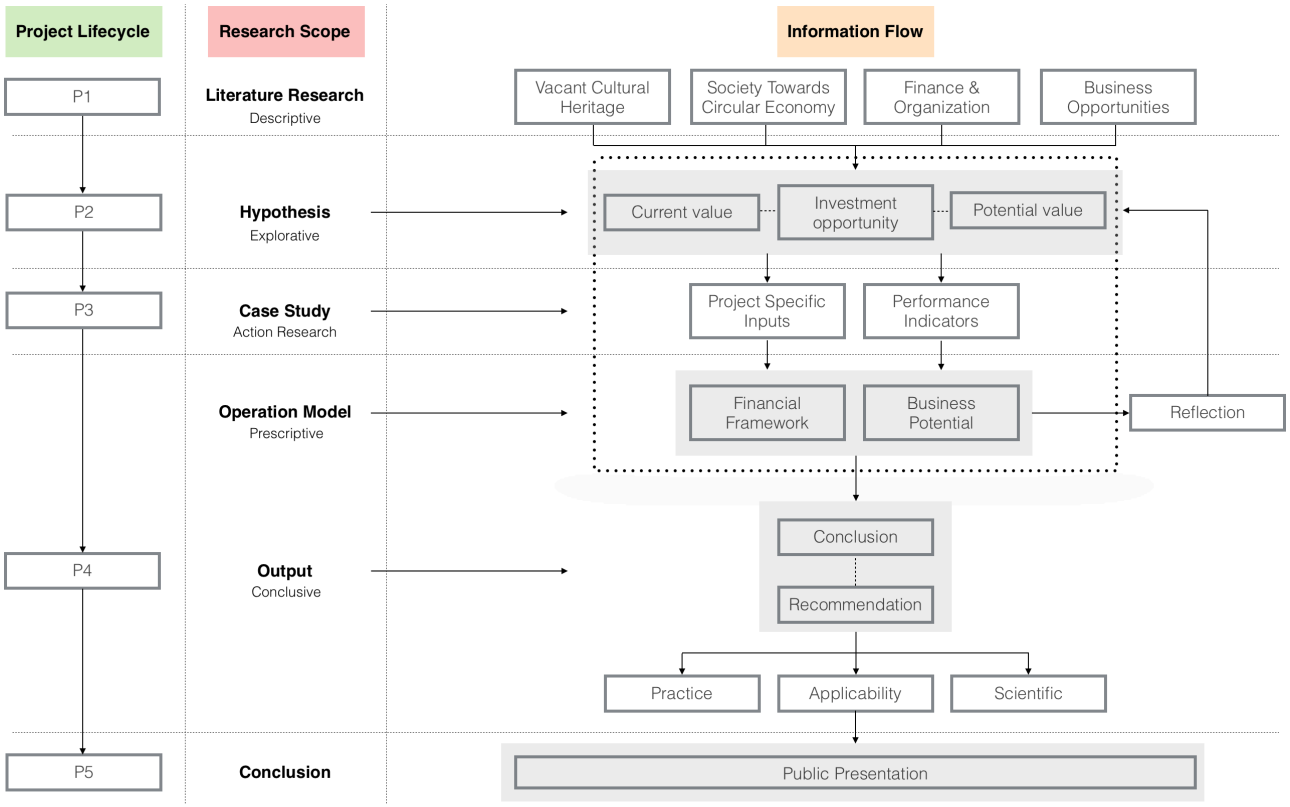

Figure 5.2: Research Design (own illustration)

Part III: Theoretical Framework

6. Case Study Analysis: Tropicana (provisional study)

Tropicana, the former subtropical swimming paradise is positioned along the river Maas. This development starting in 1987 was commissioned by Center Parcs and opened in 1988, sold in 1989 to a Scottish Brewery, and thereafter owned by Lips Capital Group since 1993. Nowadays it is commonly known as BlueCity010. With redeveloping Tropicana as impact incubator for a circular city, Rotterdam continued to become a future hotspot in which living, working and leisure activities are combined for future residents.

After Tropicana decided to close their subtropical swimming pool and offices in 2010 due to safety issues and penalties, a prominent place nearby the city center became vacant. Despite initiatives for a redeveloped and upgraded cultural centre to open in 2011, the project was cancelled and this remarkable building became neglected, waiting for a new purpose. The credit crisis possibly delayed further development of the property and due to bankruptcy in april 2015 Lips Capital Group was obligated to repel the property. Aegon was the creditor concerned with the sales, to redeem the remaining mortgage debt of €2.5 million.

Currently 30 entrepreneurs work together in this coalition to develop the overall vision and aims to set an example for the future circular city. This chapter involves the evaluation of the redevelopment of Tropicana and further elaborates on:

- Organization of the process; Which parties are involved and what fundamental differences in relation to a traditional redevelopment process could be identified?
- Financial aspects in relation to the developer, both during the redevelopment proces and in advance.
- Any disadvantages or advantages for the developer in relation to the financial budget compared to a traditional redevelopment process
- The costs, benefits and other related experiences for involved stakeholders, like the municipality, suppliers and entrepreneurs.

6.1 ORIGIN OF BLUECITY010

In 2013, after Tropicana already was left vacant for three years, this remarkable building was subject to pop-ups Aloha Bar, Kromkommer and Rotterzwam among others in order to revitalize this forgotten resort. A revision for the land use plan is proposed and would take approximately five years. Up until then these pop-ups are able to exploit their business concepts. Despite the numerous initiatives presented, mostly subject to demolition and new development of high end residential units, this building further gets into oblivion.

To bring attention to this sad appearance, Bauke van Veel (2015) gets a drone video viral, and new initiatives to save this building from dilapidation or demolition originate. Over time, multiple parties saw the opportunity to acquire the vacant building and started to design a new cultural hub. Kramer & De Jong, one of the competitors, focused on revitalizing the subtropical swimming pool concept. With an investment of €14 million euro's the original function would be introduced again. Khan envisioned a 'state of the art tennis hal', a sportstore and luxurious hotel. According to Khan 'a financially solid plan' would achieve the success of a new Tropicana.

Simultaneously to the vacancy and demolition issues, the first initiative for a circular 'blue economy' like Rotterzwam, Kromkommer and the Aloha Bar among others in 2013 arose. Subsequently the first collaborations in 2014 with the municipality of Rotterdam started and in 2015 the concept BlueCity010 was launched.

The first team started in april 2015 and existed of five professional team members, and further collaborating with coalition partners RotterZwam, stichting ifund, COUP and SuperUse studios. In

august 2015, after the aforementioned bankruptcy of Lips Capital Group in april, the negotiations with multiple stakeholders like the municipality, curator, potential partners and funds started to define the BlueCity vision. Together with ifund an investment plan was set up to further exploit the concept of BlueCity010. Unfortunately the first attempt to acquire the vacant building fails. Finally, in October 2015 BlueCity is awarded the property through an public auction, involving an €1.7 million investment.

In the first quarter of 2016 new businesses applied for rental agreements (KEES, Spireaux, Stadsimker, Gijs van Gemerden and Rebel Urban Farms) and linked the so-called 'blue economy' of this concept. During the second quarter of 2016 the first event locations were initiated, focusing on circularity.

One aspect noteworthy would be 'Nieuw plekkie voor je stekkie' (BlueCity, 2017). This concept seamlessly fits the overall purpose. With the limited available budget it is difficult to decorate the 12.000 m^2 complex. By adopting discarded plants, reuse is extending the life of plants and altogether this greenery suffices to filter the polluted air. It is a good example of a closed loop for circular economy, collecting resources as input for new use.

6.2 ORGANIZATION (PROVISIONAL ANALYSIS)

6.2.1 Involved stakeholders

Until date the redevelopment process is ongoing. Since the initiative, the organization gradually evolved, built up as follow:

- **BlueCity Team**
- five professionals and four coalition partners started. Later on new positions on the aspects marketing & communication, financing and event management were added to the team, resulting to a total of 15 team members.

- Yvette Govaart is involved with her company COUP, and responsible for the communication between all stakeholders, organizing all resources within a viable business case.

Due to the disruptive approach, collaboration between all partners is completely different. It is time consuming and therefore not lucrative for nobody - at least not in terms of direct income. *"It is extremely valuable to quantify the acquainted knowledge to money. Especially if we look at which value is retrieved based on this specific redevelopment methodology, and compare this against the traditional approach of construction."* (Y. Govaart, 2017).

The purchase costs for materials are significantly lower, and even out the higher labor and project- and process management costs. Furthermore, the additional investments for new materials are based on reusable products.

- Wouter Veer (ifund) is involved as investor, investigating the opportunities of this concept.

- **Partners**
- five partners are involved to exploit the concept. Workspot provides dynamic office solutions, to accelerate collaboration with other entrepreneurs and grows on demand.

- iFund invests to accelerate a innovative and sustainable global environment, by supporting social enterprises. iFund was awarded the acquisition of €1.7 million.
- ENGIE is energy supplier, without additional costs.
- Superuse Studios designs innovative solutions, with their open-source method and tools, to effectively reuse existing materials for new purpose.
- COUP integrates interests and ambitions of end users, owners and investor together, managing the process and required resources within circular redevelopment projects.

- **Entrepreneurs**
- over 20 enterpreneurs and startups are working together, and using the

- **Other Stakeholders**
- Municipality: starting with an civil participation functionary to negotiate the necessary permits
- (Sub)Contractors: renovates the existing mechanical systems and materials, or applies circular materials whenever necessary. BIK Bouw was responsible for renovating the former Club Tropicana, and achieved this with 90% reused materials. According to Jasper Sluimer (2017) the financial aspect was difficult: “Budgetting such a project is very difficult and only possible through open, transparent calculation”.

7. Linear Programming (provisional design)

In this chapter the linear programming model used to answer the main question is explained. Firstly, the concept of linear programming is clarified. Subsequently the hypothesis is identified in the second paragraph and all relevant actors with associated objectives and conditions presented in paragraph three, based on the given results regarding the project 'Tropicana'. The preliminary design will be presented in paragraph four. After evaluation of the preliminary design in the fifth paragraph, the last paragraph presents the final model.

7.1 CONCEPT OF LINEAR PROGRAMMING

Aforementioned problem analyses have shown the possible relation between the problem of vacancy issues of cultural heritage and the alternative solution, the urge to change towards a circular economy. Especially with vacant cultural heritage the main constraints for reuse are related to financial feasibility.

Both financial feasibility and infeasibility for a redevelopment project could be, in terms of linear programming, perceived an so-called 'optimization problem'. Within this perspective, linear programming provides the insight on or solution for the problem. As described by Dantzig, linear programming has a certain philosophy or approach to building a model that has application to a broad class of decision problems encountered in government, industry, economics, and engineering. It probably possesses the simplest mathematical structure which can be used to solve the practical scheduling problems associated with these areas (Dantzig, 1998).

"*The subject matter studied is not the equipment used, nor the morale of the participants, nor the physical properties of the output, it is the combination of these in total as an economic process."* (Herrmann and Magee, 1953-1, cited in G. B. Dantzig, 1998).

It is a method to achieve the best outcome in a mathematical model whose requirements are represented by linear relationships. In other words: it identifies the 'set of feasible solutions' in which it could contribute to achieve the most beneficial solution, such as maximum profit or lowest cost. Mathematically, a design solution or design alternative is represented by a combination of design variable values, optimization criteria and constraints (Barendse et al., 2012).

$$\text{Maximise} \quad Z = c_1x_1 + c_2x_2 + \cdots + c_nx_n$$

subject to the restrictions:

$$\begin{aligned} a_{11}x_1 + a_{12}x_2 + \cdots + a_{1n}x_n &\leq b_1 \\ a_{21}x_1 + a_{22}x_2 + \cdots + a_{2n}x_n &\leq b_2 \\ &\vdots \\ a_{m1}x_1 + a_{m2}x_2 + \cdots + a_{mn}x_n &\leq b_m \end{aligned}$$

and

$$x_1 \geq 0, x_2 \geq 0, \ldots, x_n \geq 0$$

Figure 7.1: Mathematical description of decision variables, optimization criteria and constraints (Hillier and Lieberman, 2005, cited in Barendse et al., 2012)

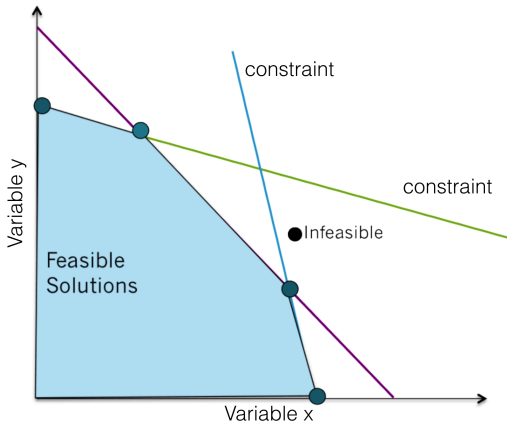

Figure 7.2: Feasible region determined by decision variables and constraints, based on Burkhow (2014) (own illustration)

7.2 HYPOTHESIS

Based on the theory of linear programming, the financial feasibility for redeveloping cultural heritage could be presented graphically. From perspective of the developer, the variable functions represent a minimum required future value based on the development costs compared to the maximum accepted market value. Figure 7.3 below shows the two scenarios considered. The first scenario on the left represents the variables determined by a traditional redevelopment proces, and provides no feasible solution. The second scenario indicates the BlueCity concept, by using circularity to provide a viable solution, which is the hypothesis of this research proposal. This hypothesis is as follows:

By redeveloping cultural heritage with circular principles a possible solution for new and financially feasible redevelopment could be created, given similar conditions in which a traditional redevelopment project without circular concepts would fail.

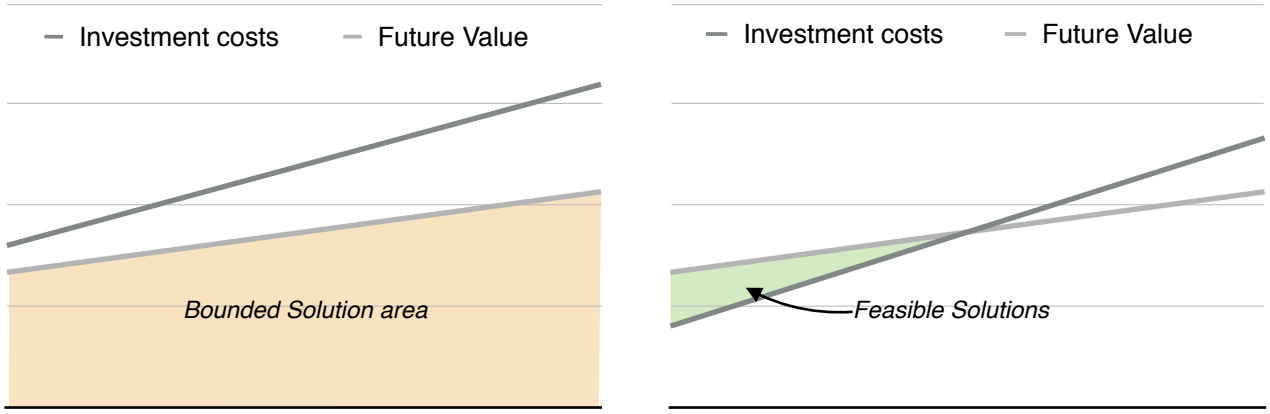

Figure 7.3 Left: development costs exceed future value; Right: circular benefits result in reduced development costs, giving a set of feasible solutions (own illustration)

Above mentioned hypothesis will be tested according to previously described case (Chapter 6). Two scenarios of the presented design solutions for redevelopment of Tropicana will be used in the linear model.

- The first scenario involves aforementioned renovation principle. Kramer & De Jong, one of the competitors, focused on revitalizing the subtropical swimming pool concept. With an investment of €14 million euro's the original function would be introduced again. Tickets of €14,50 would be suitable, and an estimated attendance rate of 300.000 annually.
- The second scenario involves the BlueCity010 concept, in which circular redevelopment would reduce initial investment costs by reusing existing materials.

The results from this case will be used to verify the first concept of this financial model. Furthermore, a new case will be introduced to further verify the stated benefits of circular redevelopment. Additional information and case selection will be presented later on, during the P3 evaluation.

Subsequently all used decision variables, optimization criteria and constraints will be evaluated and further defined though interviews (and expert panels). Most important actor will be the developer of BlueCity010, giving feedback on the proposed model. Furthermore, developers and municipality could be presented with the proposal for further validation. Conclusively, the conclusion and recommendations for this circular redevelopment model will be presented.

7.3 DECISION VARIABLES, OPTIMIZATION CRITERIA & CONSTRAINTS

The decision variables resulting from the two scenarios presented for Tropicana are separated between the variables from developers perspective and contrary from property owners perspective. Clearly the developers aim to lower investment and acquisition costs and optimize future value acquired from revenue. Contrary, the property owner aims to maximize the current price level. For the first scenario the income approach is set on the given ticket price and estimated annual attendance, without the use of circularity. The second scenario reflects the rent level of €100,-/m², related to enterpreneurships and startups, stimulating the innovations for a circular city. These values are based on literature research regarding the redevelopment of Tropicana. Further research on the presented variables is necessary to confirm the results of this model.

7.3.1 Assumed key figures for provisional LP Model

Project developer		Swimming Pool	BlueCity
Decision variables			
Revenues			
Acquisition value building	[€]	€ 2.000.000	€ 1.700.000
Future revenues	[€/m²/year]		€ 100
	[€/ticket]	€ 14,5	
	[tickets/ year]	300.000	
Building LFA	[m²]	n/a	10.625
Revenue year 1	[€]	€ 4.350.000,00	€ 1.062.500,00
GIY	[%]	8%	8%
Total future value building	**[€]**	**€ 54.375.000**	**€ 13.281.250**
Construction Costs			
Building GFA	[m²]	12.500	12.500
Management costs (15% commission fee)	[€/m²]		
Construction costs	[€/m²]	€ 1.066	€ 120
Total construction costs	[€]	€ 13.325.000	€ 1.500.000

Tabel 7.1: Assumed key figures redevelopment options from developers perspective (own illustration)

Both DCF analyses are presented in Appendix A. For this analysis the BlueCity concept shows a positive outcome. Contrary, the alternative for a Subtropical Swimming Pool is considered not viable. The initial hypothesis which states thad the circular redevelopment concept would be more beneficial, is hereby confirmed. Moreover, based on the interview with Yvette Govaart of BlueCity, the presented assumptions for renovating the swimming pool would not suffice to achieve successfully. Based on presented calculations, the renovation price would be €1.166,-/m2. Given the condition of both structural and mechanical installations like MEP and HVAC, the costs would be significantly higher. Kindly note the presented calculation is based on numerous assumptions,

and therefore additional research is necessary. Moreover the DCF analyses are based on 30 years prognoses, which probably exceeds the method used by the original idea of a subtropical swimming pool by Kramer & De Jong.

From the interview could be concluded that the process management and design criteria are the main cost drivers for circular redevelopment. “The design process is completely different from the traditional approach. Each opportunity is based on products available, not the other way around.” (Govaart, 2017).

Finally, additional research on quantifying the preservation of built capital/use value is necessary to calculate. This topic will be introduced later on in this research.

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9. Appendices

Appendix A: Provisional DCF Analyses Tropicana

Subtropical Swimming Pool	Nominal rent (€ * no. of tickets / m2 GFA)	4.350.000	Received end of the year, price level t=1
	Ticket price	€ 14,50	
	Annual sales	300.000	
	Nominal annual rent increase	1,0%	
	Current lease term	10	Length of the lease contract
	Building size (m2 LFA)	10.000	
	Building size (m2 GFA)	12.500	
	Purchase value building	€ 2.000.000,00	
	Initial investment (construction) at t=0	€ 14.000.000,00	Price level t=0
	Maintenance costs	€ 30,00	[€/m^2]
	Exploitation costs [5%/revenue]	€ 217.500,00	[€/year]
	Energy costs electricity*	1,79	[kWh/ visitor]
	Energy costs gas*	2,69	[m^3/ visitor]
	Energy costs water*	9	[m^3/visitor]
	Energy costs total**	€ 2.545.689,00	[€/year]
	Exit value building at t=20		Price level t=10
	Going-in IRR	8,0%	

	Occupancy rate (100% -Vacancy rate %)	t=	Revenue income	Exit value	Initial investment	Exploitation costs	Net Cash Flow	Present Value Cash Flow
2015	100%	0			-16.000.000	-3.138.189	-19.138.189	-19.138.189
2016	100%	1	4.350.000			-3.138.189	1.211.811	1.122.047
2017	100%	2	4.393.500			-3.138.189	1.255.311	1.076.227
2018	100%	3	4.437.435			-3.138.189	1.299.246	1.031.383
2019	100%	4	4.481.809			-3.138.189	1.343.620	987.601
2020	100%	5	4.526.627			-3.138.189	1.388.438	944.948
2021	100%	6	4.571.894			-3.138.189	1.433.705	903.477
2022	100%	7	4.617.613			-3.138.189	1.479.424	863.229
2023	100%	8	4.663.789			-3.138.189	1.525.600	824.234
2024	100%	9	4.710.427			-3.138.189	1.572.238	786.510
2025	100%	10	4.757.531			-3.138.189	1.619.342	750.069
2026	100%	11	4.805.106			-3.138.189	1.666.917	714.912
2027	100%	12	4.853.157			-3.138.189	1.714.968	681.038
2028	100%	13	4.901.689			-3.138.189	1.763.500	648.435
2029	100%	14	4.950.706			-3.138.189	1.812.517	617.091
2030	100%	15	5.000.213			-3.138.189	1.862.024	586.988
2031	100%	16	5.050.215			-3.138.189	1.912.026	558.102
2032	100%	17	5.100.717			-3.138.189	1.962.528	530.410
2033	100%	18	5.151.724			-3.138.189	2.013.535	503.885
2034	100%	19	5.203.242			-3.138.189	2.065.053	478.498
2035	100%	20	5.255.274			-3.138.189	2.117.085	454.217
2036	100%	21	5.307.827			-3.138.189	2.169.638	431.011
2037	100%	22	5.360.905			-3.138.189	2.222.716	408.847
2038	100%	23	5.414.514			-3.138.189	2.276.325	387.693
2039	100%	24	5.468.659			-3.138.189	2.330.470	367.514
2040	100%	25	5.523.346			-3.138.189	2.385.157	348.276
2041	100%	26	5.578.579			-3.138.189	2.440.390	329.945
2042	100%	27	5.634.365			-3.138.189	2.496.176	312.488
2043	100%	28	5.690.709			-3.138.189	2.552.520	295.872
2044	100%	29	5.747.616			-3.138.189	2.609.427	280.063
2045	100%	30	5.805.092			-3.138.189	2.666.903	265.030

NPV	-648.148

* Source: http://www.freitas.nl/Downloads/Cijfers%20en%20tabellen%202007.pdf (SenterNovem, 2007)

**** Source for water: (evides,2016)**

BlueCity Concept	Nominal rent (€ / m2 LFA)	100	Received end of the year, price level t=1
	Nominal annual rent increase	2,0%	
	Current lease term	30	Length of the lease contract
	Building size (m2 LFA)	10.000	
	Building size (m2 GFA)	12.500	
	Purchase value building	€ 1.700.000,00	
	Initial investment (construction) at t=0	€ 1.500.000,00	Price level t=0
	Maintenance costs	€ 15,00	[€/m²]
	Exploitation costs [5%/revenue]	€ 50.000,00	[€/year]
	Energy costs	€ 0,00	[€/m²]
	Exit value building at t=20		Price level t=30
	Going-in IRR	8,0%	Risk Free + Premium

	Occupancy rate (100% -Vacancy rate %)	t=	Rent income	Exit value	Initial investment	Exploitation costs	Net Cash Flow	Present Value Cash Flow
2015		0			-3.200.000	-237.500	-3.437.500	-3.437.500
2016	5%	1	50.000			-237.500	-187.500	-173.611
2017	10%	2	102.000			-237.500	-135.500	-116.169
2018	20%	3	208.080			-237.500	-29.420	-23.355
2019	30%	4	318.362			-237.500	80.862	59.436
2020	50%	5	541.216			-237.500	303.716	206.704
2021	100%	6	1.104.081			-237.500	866.581	546.093
2022	100%	7	1.126.162			-237.500	888.662	518.526
2023	100%	8	1.148.686			-237.500	911.186	492.285
2024	100%	9	1.171.659			-237.500	934.159	467.312
2025	100%	10	1.195.093			-237.500	957.593	443.551
2026	100%	11	1.218.994			-237.500	981.494	420.946
2027	100%	12	1.243.374			-237.500	1.005.874	399.447
2028	100%	13	1.268.242			-237.500	1.030.742	379.002
2029	100%	14	1.293.607			-237.500	1.056.107	359.563
2030	100%	15	1.319.479			-237.500	1.081.979	341.085
2031	100%	16	1.345.868			-237.500	1.108.368	323.522
2032	100%	17	1.372.786			-237.500	1.135.286	306.832
2033	100%	18	1.400.241			-237.500	1.162.741	290.975
2034	100%	19	1.428.246			-237.500	1.190.746	275.910
2035	100%	20	1.456.811			-237.500	1.219.311	261.601
2036	100%	21	1.485.947			-237.500	1.248.447	248.011
2037	100%	22	1.515.666			-237.500	1.278.166	235.107
2038	100%	23	1.545.980			-237.500	1.308.480	222.854
2039	100%	24	1.576.899			-237.500	1.339.399	211.222
2040	100%	25	1.608.437			-237.500	1.370.937	200.181
2041	100%	26	1.640.606			-237.500	1.403.106	189.702
2042	100%	27	1.673.418			-237.500	1.435.918	179.758
2043	100%	28	1.706.886			-237.500	1.469.386	170.322
2044	100%	29	1.741.024			-237.500	1.503.524	161.370
2045	100%	30	1.775.845			-237.500	1.538.345	152.877

NPV	4.313.560